OCTOBER, 1934

METALS & ALLOYS

The Magazine of Metallurgical Engineering

PRODUCTION • FABRICATION • TREATMENT • APPLICATION

Current Metallurgical Abstracts

PREVIEW OF THE NATIONAL METAL EXPOSITION—Pages A1-A68

you CAN'T miss us
AT THE NATIONAL METAL EXPOSITION

Welcome!

BOOTH
133
OCTOBER
1-2-3-4-5
1934

Come to the Republic Exhibit this year expecting to see something different, and you will not be disappointed. A visit will prove a liberal education and an inspiration.

Here you will find tangible evidence showing what other steel users have done by taking advantage of the progress made during the last year by the world's largest producer of alloy steels. Here you will find new alloys developed to meet new needs—stainless steels applied to combat heat and corrosion as encountered in almost every industry.

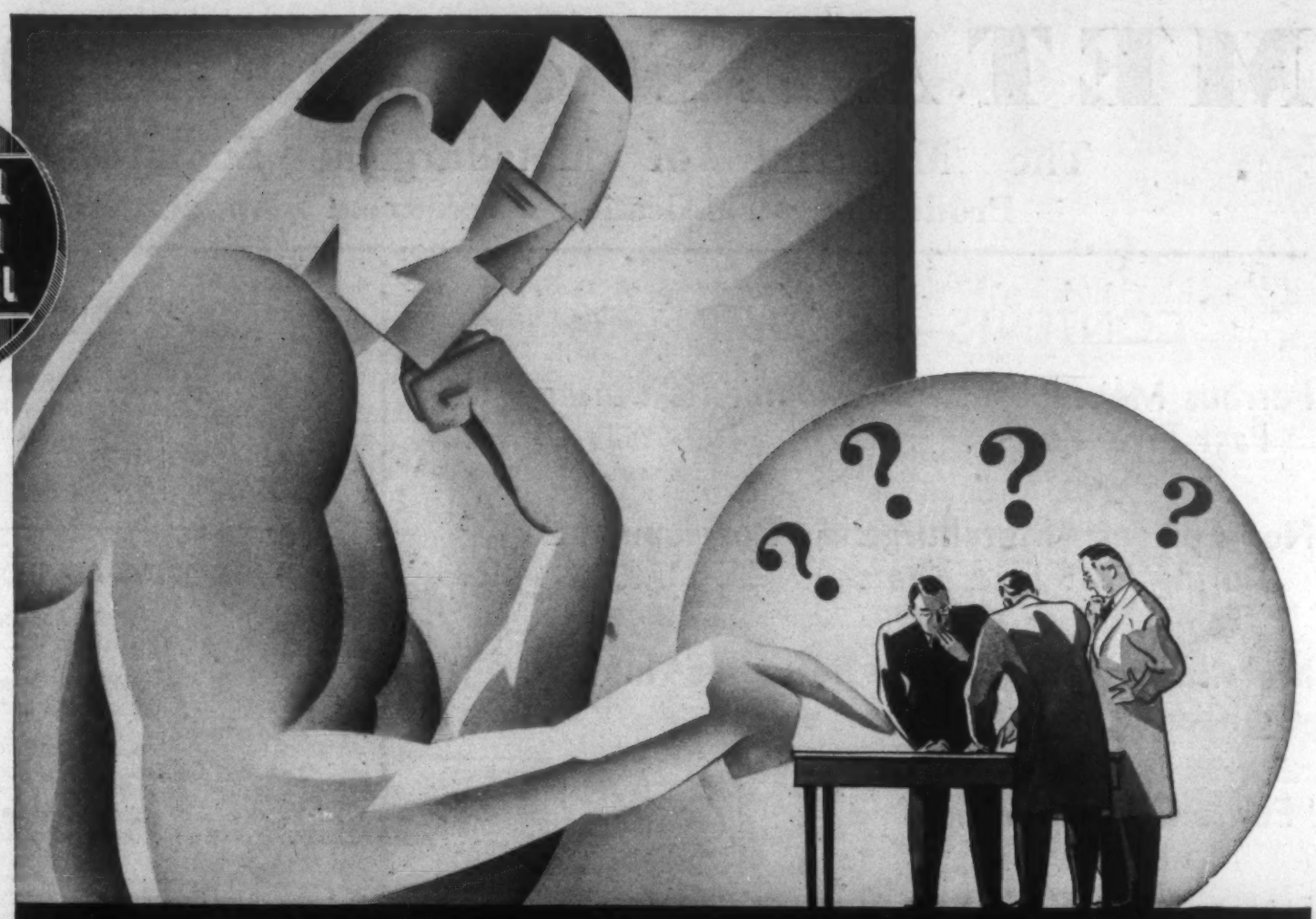
Metallurgists who really know steels will be on hand to answer your questions—to help you with your steel problems—and to offer suggestions.

Meet your friends in Republic's Exhibit where you can spend waiting time to good advantage. You are always welcome.

REPUBLIC STEEL
CORPORATION
GENERAL OFFICES: YOUNGSTOWN, OHIO

Metals & Alloys, published monthly by Reinhold Publishing Corporation. Publication office: East Stroudsburg, Pa. Executive offices: 330 West 42nd St., New York, N. Y. Entered as second class matter June 12, 1934, at the Post Office at East Stroudsburg, Pa., under the Act of March 3, 1879. $3.00 a year in U.S.; foreign, $4.00. Vol. 5, No. 10.

GOOD WILL BASED ON GOOD STEEL



MEETING MODERN NEEDS *Economically*

TIMKEN Alloy Steels are keeping pace with modern advancements in all types of products as Timken research and production men pit their combined experience against problem after problem.

To meet these modern needs efficiently, chemical and physical properties have been raised to new high standards of quality and uniformity. Grain size control—pioneered by Timken—has been developed to a high degree of accuracy. Metallographic structure has been steadily improved.

Out of this concentration of metallurgical thought and steel-making skill have come alloy steels having greatly increased endurance in service with outstanding economies in fabrication... forging, machining and heat treating.

Does the steel you are now using give you the advantages of the latest developments? It will pay you to make sure. Timken metallurgists will be glad to contribute their assistance.

THE TIMKEN STEEL AND TUBE COMPANY, CANTON, OHIO

District Offices or Representation in the following cities: Detroit Chicago New York Los Angeles Boston Philadelphia Houston Buffalo Rochester Syracuse Tulsa Cleveland Erie *World's Largest Producer of Electric Furnace Steel*

TIMKEN ALLOY STEELS

ELECTRIC FURNACE AND OPEN HEARTH • ALL STANDARD AND SPECIAL ANALYSES

METALS & ALLOYS

The Magazine of Metallurgical Engineering

Production • Fabrication • Treatment • Application

CONTENTS—OCTOBER, 1934

Ferrous Metallurgical Developments During Past Five Years 207
H. S. Rawdon

Non-Ferrous Metallurgical Developments During Past Five Years 213
Sam Tour

Metallurgical Advances Reflected in Engineering Design 217
Robert W. Carson

"For to Catch a Whale" 221
John Howe Hall

Internal Stresses—Part V 224
Charles S. Barrett

Copper as an Alloying Element in Steel . . 227
H. L. Miller

CURRENT METALLURGICAL ABSTRACTS

Ore Concentration ..... MA 471
Ore Reduction ..... MA 471
Melting, Refining & Casting ..... MA 472
Working of Metals & Alloys ..... MA 474
Heat Treatment ..... MA 476
Furnaces, Refractories & Fuels ..... MA 478
Joining ..... MA 482
Finishing ..... MA 485
Testing ..... MA 487
Metallography ..... MA 490
Properties of Metals & Alloys ..... MA 493
Effect of Temperature on Metals & Alloys ..... MA 494
Corrosion & Wear ..... MA 496
Applications of Metals & Alloys ..... MA 498
General ..... MA 499

Highlights ..... A 79
Editorial Comment ..... A 81
Letters to the Editor 229
New Equipment and Materials ..... MA 502
Manufacturers' Literature ..... MA 505

PUBLICATION OFFICE:
East Stroudsburg, Pa.

H. W. GILLETT, Editorial Director
Battelle Memorial Institute,
Columbus, Ohio

RICHARD RIMBACH, Editor

EDITORIAL ADVISORY BOARD

H. A. Anderson
Western Electric Company

William Blum
Bureau of Standards

A. L. Boegehold
General Motors Corporation

P. H. Brace
Westinghouse Electric & Mfg. Co.

R. A. Bull
Consultant on Steel Castings

Junius D. Edwards
Aluminum Company of America

O. W. Ellis
Ontario Research Foundation

H. J. French
International Nickel Company, Inc.

S. L. Hoyt
A. O. Smith Corporation

J. B. Johnson
Wright Field, Air Corps, War Department

John Johnston
United States Steel Corporation

James T. Mackenzie
American Cast Iron Pipe Company

John A. Mathews
Crucible Steel Company of America

C. A. McCune
A. V. de Forest Associates

R. F. Mehl
Metals Research Laboratory, C.I.T.

W. B. Price
Scovill Manufacturing Company

Leo F. Reinartz
American Rolling Mill Company

H. A. Schwartz
National Malleable & Steel Castings Company

F. N. Speller
National Tube Company

Jerome Strauss
Vanadium Corporation of America

WM. P. WINSOR, Advertising Manager
Editorial and Advertising Offices:
330 West 42nd St., New York, N. Y.
Branch Offices:
G. E. Cochran 706 Straus Bldg. Chicago, Ill.
R. M. Creaghead 433 Bulkley Bldg. Cleveland, Ohio

NRA MEMBER U.S. WE DO OUR PART

Published Monthly by
REINHOLD PUBLISHING CORPORATION
Ralph Reinhold, Pres.-Treas.
Philip H. Hubbard, Vice-Pres.
H. Burton Lowe, Vice-Pres.
Francis M. Turner, Vice-Pres.

Annual Subscription: U. S. Possessions, $3.00. All Other Countries, $4.00 (Remit by New York Draft). Single copy 40 cents.

Copyright, 1934, by **Reinhold Publishing Corporation.** All rights reserved.

Entered as second-class matter June 12, 1934, at the post office at East Stroudsburg, Pa., under the Act of March 3, 1879.

HIGHLIGHTS

by H. W. GILLETT

DO YOU want to know what metallurgical engineers are saying, the world over? Look in the Current Metallurgical Abstracts. Here are some of the points covered by authors whose articles are abstracted in this issue.

Scale Elimination

Nealey in discussing scale elimination (page MA 474 R 1) by luminous radiant flame heating, once more revives the "smoky" flame idea to take its place against that of perfect combustion.

Forging

Voss (page MA 474 R 3) gives the results of an investigation of the effect of forging on physical properties.

Wire Drawing

Bonzel (page MA 474 R 8) has prepared a very complete discussion of all phases of wire drawing. Considerable data are quoted from the literature as well as from the author's own experience.

Finish Machining and Surface

Wallichs and Frank (page MA 475 R 4) found that as speed of machining was increased the surface became rougher till a "critical cutting speed" was reached, after which the surface again became smoother, but not so smooth as below the critical cutting speed.

Contraction Stresses in Butt Welds

Schulz and Püngel (page MA 482 R 8) found internal stresses as high as 16 kg./mm.^{2} (22,750 lbs./in.^{2}) in a plate 6 mm. thick (¼ inch). Covered electrodes gave higher stresses, raising current lowered stresses while stresses increased slightly with thicker plate.

Electric Smelting and Melting Furnaces

Taussig (page MA 478 L 1) deals in his book with the design of large smelting and melting furnaces. This will be valuable to all those concerned with such furnaces. Aronov (page MA 482 L 8) has written an article on Russian electric furnaces while another German book on electric furnaces was written by Bräuer and Reitstötter (page MA 482 L 1).

Non-Destructive Testing

Under the heading of Magnetic Testing (page MA 489 L 1) are several articles on testing of welds. The several methods are appraised in a single article by Pfaffenberger (page MA 489 L 6).

Wear Resistance of Alloy Rails

An article by Ros (page MA 491 R 7) discusses alloy rails in European service that are said to show superior wear resistance and freedom from fracture. A Mo-Cr-W-Si alloy steel is said to have good points.

Gases in Metals

Yensen and Herty (page MA 473 L 5) discuss the terminology relating to non-metallic elements, and suggest a clarification of the present confusion on the subject.

Low Temperature Tests on Steels

Gruschka (page MA 492 R 6) carried out tests on several carbon steels, Armco iron and four nickel steels down to temperatures of —195° C. (—320° F.).

Romantic Copper

The book by Joralemon on "Romantic Copper" (page MA 498 R 1) is interesting to all metallurgists whatever their degree of advancement.

Corrosion

Lewis and Evans (page MA 496 L 8) discuss the inhibitive action of pigments on rusting.

Can Openers and Chipping Hammers

Last month one of the abstracts stated that 300 tons of steel annually went into making can openers; this month we find (page MA 497 L 10) only 100 tons go into the manufacture of pneumatic chipping hammers.

Vacuum Furnaces in Metallurgy

Ziegler in a correlated abstract (page MA 478 R 5) discusses the reactions taking place between metals and gases surrounding them at high temperatures. We will hear more of vacuum melting as time goes on.

GNATS' WHISKERS

A Reference to Tolerances

CAPT. TRAPROCK in the report of his most recent researches places the average diameter of an adult male gnat's whiskers at two ten-thousandths of an inch.

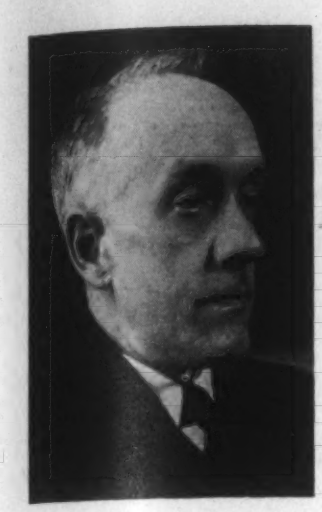
Perhaps you are not interested in gnats' whiskers, and then again you may be making parts that have to fit to a gnat's whisker *and stay that way*. If so, a **STABILIZED ZAMAK-3 DIE CASTING** will interest you for its economy and permanent accuracy of dimensions. If your interest is in parts requiring only the usual machine fit accuracy, you can have this in Zamaks 2 or 5 or an unstabilized 3. Zamak-3 is apt to be your preference because of its permanent high impact strength and ductility.

The point we'd like to make is that much of the talking we've done about dimensional permanence in this series of technical advertisements, has dealt with tolerances of one or two ten-thousandths of an inch per inch. Put in plain English we've simply been trying to tell you that **ZAMAK DIE CASTINGS CAN BE HAD WHICH PERMANENTLY FIT TO THE PROVERBIAL GNAT'S WHISKER.**

NOTE: *In this advertisement for the readers of Metals and Alloys, The Research Division of The New Jersey Zinc Company begins to talk the Advertising Division's language. But they are still prepared to back their statements with data from their files.*

HORSE HEAD (99.99+% UNIFORM QUALITY) ZINC

THE NEW JERSEY ZINC COMPANY, 160 FRONT STREET, NEW YORK



EDITORIAL COMMENT

"The World Do Move"

WE HAVE never been greatly interested in "Annual Reviews" of the progress of a calendar year in the metallurgical field, since few developments of value can be ascribed to any one twelve-month period. The big things are matters of slower development. Whether it be the flowering, into the production and sale of that alloy for that use, of an idea that some alloy, old or new, would be economical and satisfactory for making some new convenience or some new gadget, or whether, in the field of technical information, some new and illuminating theory is propounded as the outgrowth of someone's lifetime of thought and observation, the bringing of any such matter to a head so that it gets commented upon in an annual review has been preceded by so much work that no metallurgical birth certificate can set down a very definite date.

Over a longer period, definite accomplishments and definite trends can be noted with greater certainty. METALS & ALLOYS issued "Vol. 1, No. 1" in July '29, a little over five years ago, and its articles and abstracts have given a running record of metallurgical progress in that period. It has seemed fitting to take a bird's eye view of what we have today, metallurgically, that we didn't have five years ago. Articles by Rawdon, Tour and Carson in this issue summarize progress in various fields of interest; so we need here to comment only on general trends.

Conditions were quite different in the summer of '29 from what they are in the fall of '34. In the former period depressions were quite generally held to be things of the past as far as the United States was concerned, and the slough of despondency into which we later fell, and the floundering efforts we are still making to emerge from it, were not anticipated.

How has metallurgical progress fared during this tough period? In many cases the production, control, and research staffs were skeletonized, and efforts to improve quality, lessen cost of production, and find new processes, products and applications for them were curtailed. Defeatism as to technical progress, expressed in "Technocracy," and in some phases of the many proposals put forth by the more crack-brained among "new-dealers," arose to propose a moratorium on technical betterments. But neither producers, users, nor the public at large accepted the idea of stagnation. Indeed, the period of prolonged low production gave opportunity for the application of ideas whose trial would have held back normal production schedules during the breaking-in stage.

The step from knowledge to its application seems to have been taken about as fast in the depression as in normal times. The stabilization of 18:8 against weld decay became rather well accomplished, and so many uses for 18:8 cropped up that the big steel companies could see that it was a coming tonnage proposition and took up its manufacture. Calls for economical high-yield strength steels brought a variety of low-alloy steels to the fore for structural purposes. Construction by welding went on apace, and the competition of welding as well as the call for castings of superior properties made high-test and alloy cast irons more common and started a growing development in quenched and tempered steel castings.

Recognition of the effects of tiny impurities and the availability of very pure zinc overcame the old trouble of disintegration of zinc-base die castings, so that they came into a phenomenally wide range of industrial uses.

Better knowledge of precipitation hardening effects brought into commercial production quite a range of copper-base alloys of superior strength, such as those with Be and with Ni and Si, Al, or Sn. Aluminum or its alloys found uses in architecture, in heat insulation as foil bounding stagnant air spaces, and as automobile cylinder heads.

The oil industry took up the 5% Cr ½% Mo still tube steel, with its combination of reasonable corrosion resistance and fair high-temperature properties at a moderate cost.

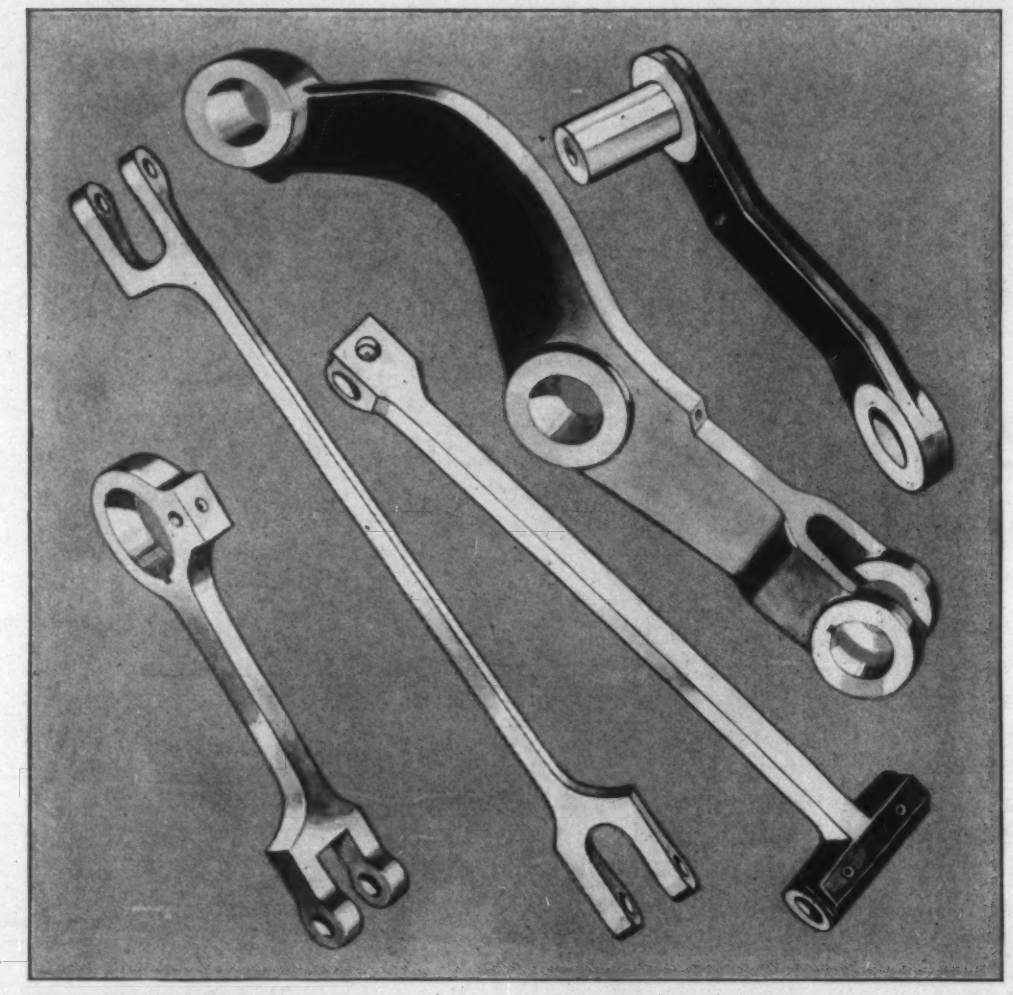
Knowledge of "the physical chemistry of steel making" and of the effect of non-metallic inclusions in a sufficiently fine state of division and uniform distribution made possible control of grain size and of aging properties in tonnage steels.

Melting furnaces, heat treating furnaces, and rolling processes all became more automatic and more economically operated. Devices brought in from the realm of physics, such as the "electric eye," were applied. Melting machines and heat-treating machines are taking the place of furnaces. Controlled atmospheres are being used as a matter of course. Copper brazing has become a commonplace.

The tungsten carbide class of cutting tools has expanded both as to types of materials and variety of applications, and "powder metallurgy" has continued to be applied to bearings whose duty is not too severe and is being considered for use with a wide variety of metals.

Installation of new continuous rolling mills and of special backed-up rolls has proceeded. Some devel-

(Continued on page A83)



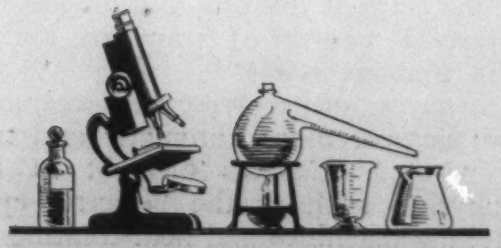
Forgings worthy of your Good Name

ASCO FORGING BILLETS

When you use Asco Forging Billets you know the finished forging will be of undisputed high quality, worthy to bear your good name.

To stand up under extreme stresses and abuse, your forgings demand the finest forging billets, produced under the most exacting laboratory control, from the selection of raw materials through processing in the furnace, teeming, rolling, with liberal discard at the shears to eliminate pipes and blowholes, thorough chipping and repeated inspections.

The use of Asco Special High Grade Forging Billets and Slabs, is your assurance of quality, your guarantee of unmatched performance in the finished forgings.



Our Metallurgical Laboratories are at your service in developing special steels for special purposes.

THE ANDREWS STEEL CO., NEWPORT, KENTUCKY

Carbon, Chrome, Chrome Molybdenum, Chrome Nickel, Chrome Vanadium, Molybdenum, Nickel, Nickel Molybdenum, Vanadium Billets and Slabs.

opments in improved mill equipment requiring large capital outlays have, however, been shelved waiting for the time, as one operator put it, "when we shall know whether some government alphabetical commission, the labor unions, or the management, is going to run the mill."

Alloying elements that have been taken out of the category of "rare" or "nuisance" elements and put to work commercially are Be in Cu, Te in Pb, Se in free-machining steels, N in high-Cr alloys, among others.

While many of these developments are traceable to prior and continuing activities of individual firms, and separate attack upon specific production problems is being carried out in the effective, individualistic manner that best fits such problems, it is noteworthy that joint attack on basic problems affecting many producers and consumers has flourished. True, some research associations and institutes did not weather the storm, but others, like the Copper and Brass Research Association, took on renewed vigor.

The Metallurgical Advisory Board took up the work on physical chemistry of steel making that had been abandoned by the Bureau of Mines and completed its progress with far-reaching effects on production methods and even more far-reaching ones on the habits of thought of superintendents and furnace operators. The "Open Hearth Committee," fostered by the A. I. M. E., has developed into a permanent and most constructive feature of steel production metallurgy.

Collective action, through A. S. T. M. committees, often coöperating with other societies, has clarified problems of embrittlement of structural steel, high-temperature creep and fatigue properties of metals, many corrosion problems, and so on. Collaboration of the A. S. T. M. with the A. F. A. and the A. S. M. E. has brought forth the vastly useful Symposia on high-temperature properties, steel castings, and cast and malleable iron.

Engineering Foundation and the coöperators in the Alloys of Iron Research have published several monumental monographs that have met with widespread approval.

The technical metallurgical societies have continued their traditions of service through times that were very parlous for them. The A. S. S. T. avowedly entered the non-ferrous field and became the A. S. M. It, the A. S. T. M., A. I. M. E., A. F. A., and other similar societies, kept up the volume of their publications, as our abstract columns show, and managed to retain a sufficient proportion of their members even through the worst of the storm, so that the permanence of these organizations is more assured than ever. When membership is considered so essential that it is retained at a real sacrifice, as it has been by many of the members, one can be sure that the societies are truly rendering service and that the thirst for metallurgical information is unquenched.

Fundamental research, to find out the "why" of things and get answers to basic problems that will stand the test of time because they are the result of sufficiently comprehensive investigation, has had its ups and downs. Among the downs is the governmental ham-stringing of the Bureau of Standards and Bureau of Mines, to whom the country used to look for much of this type of information, and some curtailment of that sort of work by several large corporations. Among the ups are the continued allegiance to such work by such firms as the Aluminum Company of America, the fine work done by the Research Laboratory of the Steel Corporation, the development of the Metals Research Laboratory at Carnegie Tech, and the fact that the Universities, Institutes, and Foundations engaged in such tasks still carry on.

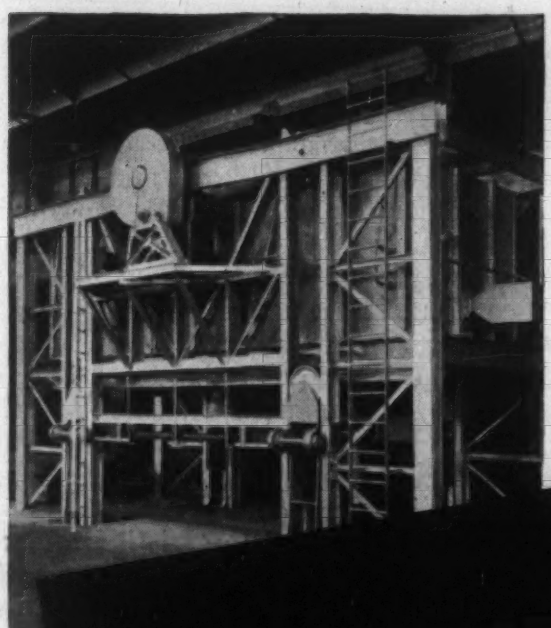
With the results of metallurgical knowledge affecting metallurgical engineering as they have through the last five years, with the demand for information, especially for that which has been condensed and correlated for the busy man, no less active than before, the mission of METALS & ALLOYS to supply metallurgical information and facilitate its application to practice seems to us as vital as it did in '29.

The past five years have been difficult ones for any technical and engineering publication, and the publishers have had to content themselves with balancing a negative net income, month by month, against the satisfaction of service and the hope of better times. There *is* a satisfaction in service, not the least of which, in this case, comes from the expressions of reader interest and from the hearty and active coöperation of the Editorial Advisory Board. It is pleasant to have played some part in the advancement of metallurgical engineering, to have continued to play it through tough times, and then to look back over the five-year period and see that despite depressions and business, economic, and political vicissitudes the metallurgical world "do move."

H. W. GILLETT.

Hot Billet Shear (Courtesy Andrews Steel Company)

HOW YOU CAN IMPROVE QUALITY AND REDUCE COSTS WITH CONTROLLED* G-E ELECTRIC FURNACES



Controlled heating, cooling, and atmosphere in this G-E elevator-type furnace make a perfect combination for the annealing, without oxidation, of steel sheets, strip, bars, etc.

"Our annealing costs have been reduced 10 to 20 per cent," says the user of these four G-E bell-type furnaces.

Battery of rectangular bell-type furnaces used for annealing silicon-steel sheets. Uniform temperature distribution is a feature.

If you make ferrous or nonferrous coiled strip, tubing, or wire, G-E bell-type controlled* annealing furnaces will bright-anneal your product quickly, uniformly, and economically. These furnaces have no heavy pots or covers; hence the amount of heat supplied to dead weight is negligible. This means faster heating-up time, and a more uniform heat distribution. The result: quicker shipments at lower cost, with improved quality.

If you make steel sheets, G-E rectangular bell-type furnaces will save you time and money. With them, you won't have to put your sheets into heavy iron boxes to prevent oxidation. Controlled atmosphere and cooling do the trick. The uniform temperature distribution assures even annealing, with improved quality, at low cost.

For annealing steel sheets, strip, bars, tubing, and punchings, the G-E elevator-type controlled* electric furnace offers you all of the above advantages. For complete information on these and other furnaces in the complete G-E line, address the nearest G-E office, or General Electric, Dept. 6B-201, Schenectady, N. Y.

YOUR BEST SALES APPEAL TO-DAY IS QUALITY—YOUR BEST ASSURANCE OF QUALITY IS ELECTRIC HEAT-TREATMENT

170-12

GENERAL ELECTRIC

FERROUS METALLURGICAL DEVELOPMENTS During Past Five Years†

By H. S. Rawdon*

IT IS WELL recognized in legal procedure that several witnesses testifying upon the same event usually differ considerably in many respects although all may agree upon the main facts. Complete agreement in everything arouses suspicion. In like manner in reviewing the metallurgical accomplishments of the past five years, it is to be expected that two reviewers will agree only as to the big accomplishments, those which are really outstanding. Developments which are on the way are naturally rated very differently by different reviewers.

The following résumé of the metallurgical "high spots" of the past five years in the ferrous field represents the writer's personal appraisal of developments made although it is evident that a great many of the accomplishments listed would also be chosen by other reviewers. The review has naturally been confined almost entirely to the American industry and with special emphasis upon the practical accomplishments—new materials and new processes. The subjects of smelting and refining have not been included.

Stainless Steel

Without question, all reviewers would rank the development of the chromium-containing steels or the "stainless steel" industry as "head and shoulders" above other metallurgical accomplishments of the past few years. It is only within a relatively short time that the name "stainless" as applied to metal has been added to the average man's vocabulary. Although all of the types of material to which this name is generally applicable were well on the way before 1928, their successful commercial development and utilization are recent. The applications have increased in number and variety by leaps and bounds during the past five years. In particular, the austenitic alloy, commonly called "18-8," has risen from relative obscurity to a dominating position in the entire stainless field.

This field is now an exceedingly broad one and because of the multitudinous trade names used, often for materials differing in no essential respects from one another, is usually regarded with confusion and bewilderment by all except the specialist. In a list of approximately 600 trade names of corrosion-resistant and heat-resistant alloys in the Book of Stainless Steel published by the American Society for Metals, 75% refer to alloys containing chromium as the predominating constituent. Incidentally, this book should be noted as one of the outstanding accomplishments in the stainless field, both for the wealth of assembled information and for its influence in systematizing this field, at least from the material-engineer's or consumer's outlook.

Practically all of the materials to which the name "stainless steel" can rightfully be applied can be grouped into a small number of classes. The low-carbon chromium steels (C less than 0.12% and Cr 11 to 14%, often called "stainless iron") and the high-carbon stainless steel (C over 0.20%, Cr 12 to 16½%) respond to heat treatment. The chromium ferritic alloys (C below 0.12%, Cr 17 to 19%) do not, nor do the austenitic alloys of Cr and Ni of which "18-8" and "25-12" are the most widely known. All of these are available in wrought condition. The heat-resisting chromium alloys containing Cr (20 to 30%) may be wrought if the carbon is relatively low (below 0.30%).

The name "stainless" is also often loosely applied to rather complex alloys containing chromium, usually in the form of castings for corrosion-resisting and heat-resisting purposes, for which the designation "steel" can not be justified. The practice is now favored of using the term "corrosion-resistant" instead of "stainless" especially in specifications.

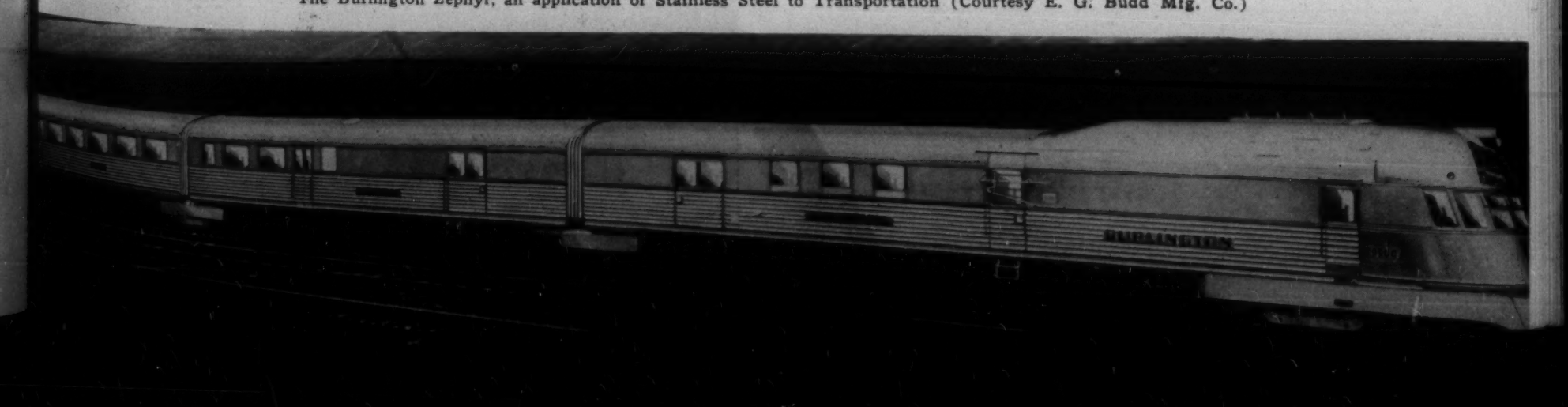
Reference to the wide variety of uses to which these materials are being put can best be made by some representative illustrations. Resistance to hydrochloric acid is still an outstanding problem. "Stainless steel" is not generally suitable. The problem of handling dilute sulphuric acid and mixed acids is also one for which there is no simple remedy which is generally applicable.

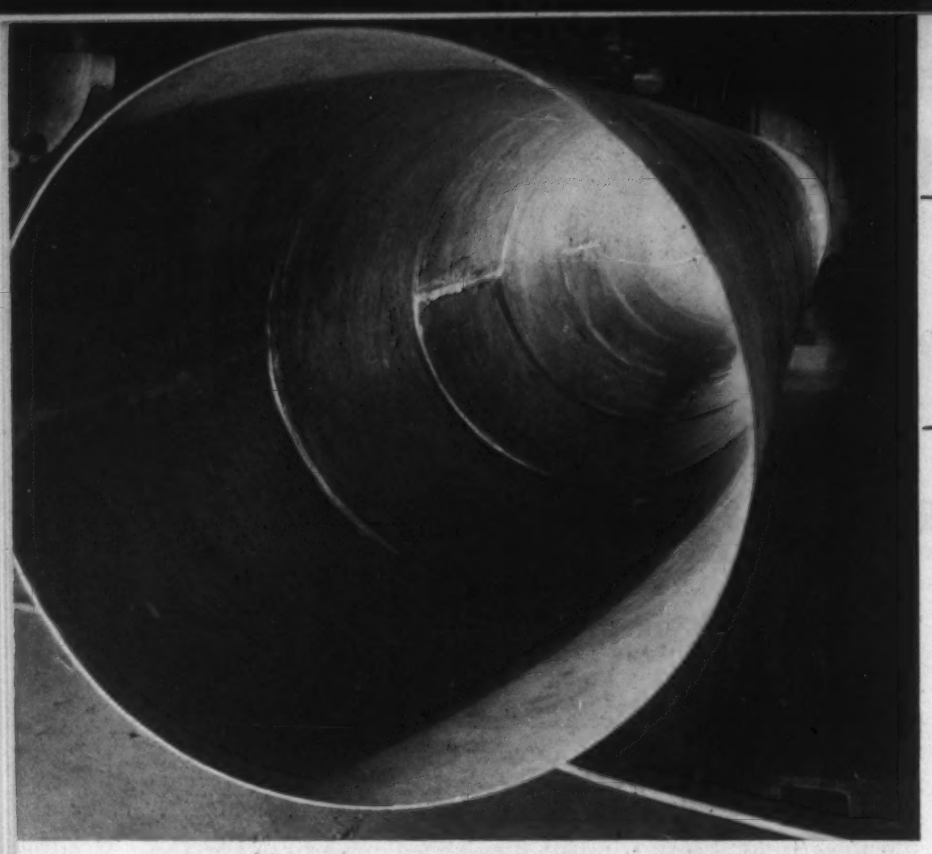
A noteworthy accomplishment in the stainless field is the development of "stainless clad" sheet steel, a material which can be worked up into a variety of shapes. The development of stainless-clad steel wire at a moderate price would indeed be a great advance.

The development of stainless has not been smooth sailing, however. One of the most serious handicaps

* Chief, Division of Metallurgy, National Bureau of Standards.
† Publication approved by the Director of the National Bureau of Standards of the United States Department of Commerce.
Note: Illustrations used in the article were collected by the editorial staff of Metals & Alloys.

The Burlington Zephyr, an application of Stainless Steel to Transportation (Courtesy E. G. Budd Mfg. Co.)





The Cream City Boiler Co. fabricated Plychrome into an 1800 foot line of pipe ranging from two to five feet in diameter. A section of this pipe is shown at the left. (Courtesy Illinois Steel Company)

has been the deterioration by intercrystalline embrittlement of the austenitic type of steel, such as "18-8," after long heating and also by corrosion at ordinary temperatures. The solution of this problem is an achievement worthy of mention. It has been found that the incorporation of a relatively small amount of a strong carbide-forming element into the steel forestalls the formation of chromium carbide and the depletion of chromium within the grains which is responsible for the undesirable behavior. Titanium used in this manner "stabilizes" the steel and enormously lengthens its useful life at high temperatures. Columbium is a somewhat more potent element for the purpose though not so available as titanium.

Welding

In spite of the fact that welding is now commonplace any one reviewing the past five years cannot help being impressed by the marked achievements, both in the size of the projects and in the varied applications of welding to the newer steels. The proud boast of the welding expert that there is no steel or iron which cannot be successfully welded is literally true. The marked success attained in welding the corrosion-resistant steels is the latest accomplishment. Although heat treatment after welding is advisable with these materials, the claim is made, and with considerable supporting evidence, that, by the use of welding rods of properly "stabilized" steel, a welded austenitic stainless steel is entirely satisfactory, with respect to corrosion-resistance, without heat treatment.

A few recent welding achievements, notable especially for size are: an all-welded 22-story skyscraper, a 214-ft. welded freighter, the world's longest all-welded bridge (Dresden, Germany), miles and miles of pipe lines consisting of welded pipe with welded connections, and welded oil-cracking stills operating under a pressure of 400 lbs./in^2 at 1000° F. Welded hollow steel airplane propellers are now in use and the application of welding in ordnance work such as gun caissons has been revolutionary.

The Budd Company's "shot welding" process ranks as a remarkable advance in welding technique. Though analogous to spot welding, the change in the metal can be confined to a very small volume of metal and thin sheets may be welded so that none of the welded portion is exposed, a very important feature in high chromium steels or other materials in which corrosion may be a factor. The sheets may be fed through the machine and the successive "shots" form a seam as in a sewing machine. Complex members can readily be built up from thin sheet with none of the welds exposed. The development of "Elkonite" though not a ferrous material, deserves mention. This material, sintered tungsten in a matrix of copper, has added greatly to the success attained in resistance welding by its use for electrodes. The successful application of arc welding and resistance or flash welding in the manufacture of pipe from steel strip has had wide-reaching influence in the pipe manufacturing industry.

The use of the fusion-welding method, either arc or gas, for the hard-facing of surfaces which must withstand excessive wear has been extended greatly. Stellite or some other tungsten-bearing alloy is commonly used for building up these hard surfaces and the method is finding wide successful application as for oil-well drills, in the building stone industry, valve seats for internal combustion engines, the facing of blades used for the hot and cold shearing of metals, the building up of worn dies and other parts, to mention only a few. Even the humble plowshare has been given a life almost unbelievable.

"Flame machining," an extension of flame cutting, is a recent outstanding development very useful and time-saving for the preliminary shaping of carbon steel parts. Operations approaching planing, milling, turning and even boring, can be carried out with a surprising degree of accuracy.

Wrought Iron

A revolutionary change in the manufacture of wrought iron was consummated about 4 years ago by

Basement Mains (8" low pressure steam and 6" medium pressure steam) are welded in the Willard State Hospital at Willard, N. Y. (Courtesy Air Reduction Sales Company)

Centrifugally Cast Liners made in "Ni-Resist" and Nickel-Chromium Cast Iron by Janney Cylinder Co. (Courtesy The International Nickel Co., Inc.)

a leading manufacturer whose name has been used for decades as a standard of quality of wrought iron. The entire puddling furnace method was replaced by a new process wherein the iron is refined as in the making of steel and then incorporated while still molten with the desired amount of molten slag. The process is carried out upon a very much larger scale than has been possible hitherto in hand puddling. Laboratory tests have not shown any important differences between this material and "regular" wrought iron and the limited service data available since the advent of the new material support the laboratory data. The anticipated expansion in the use of wrought iron for sheet and other uses has not been fully realized on account of prevailing economic conditions. However, sheet and strip materials are available commercially and alloy wrought iron has passed the experimental stage.

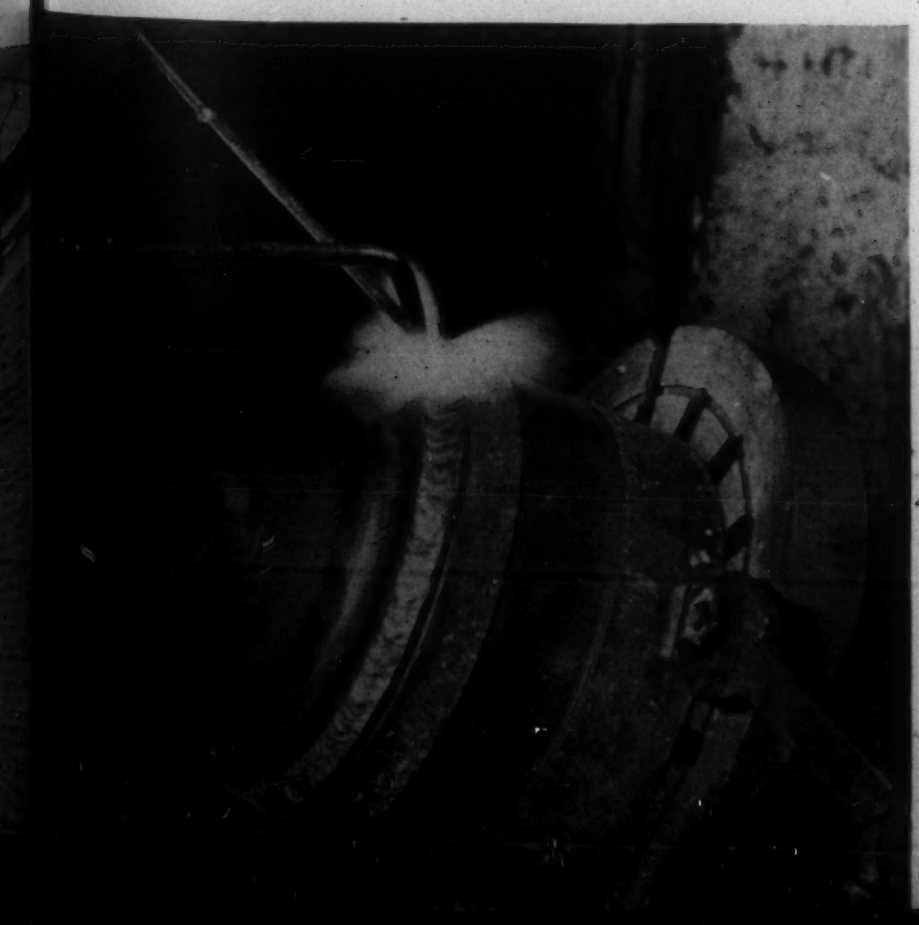
Plain Carbon Steels

In the field of plain steels marked advances have been made especially along three lines. The most important of these, undoubtedly, is the recognition by steel makers of what users have long contended—the fact that heats of steel of the same composition often differ noticeably in their properties and especially in their response to various fabricating operations. The observations of McQuaid and Ehn of a dozen years ago on the so-called "normal" and "abnormal" behavior of carburizing steel have been fully substantiated and it has been shown that other types of steel behave similarly. Within the past five years, the practice has become fairly common for many steel makers to supply steels of a desired composition having a certified grain size and a standard of grain size has been drawn up and promulgated by the American Society for Testing Materials.

Grain size forms an admirable criterion or index of other important characteristics of a steel. The austenitic grain size, as determined by carburizing the steel, is most conveniently used in comparing steels. Steel which has a small grain size and maintains it at high temperatures obviously has uses which are not so well met by a coarsely grained steel although of the same composition. This difference in properties is shown in such lines as machinability; response to carburizing, to annealing, and to normalizing, depth of hardening; distortion during hardening; toughness; ease of forging, and creep strength at elevated temperatures.

Other advances in the field of plain steels relate to the aging characteristics of steel particularly as related to sheet steel for drawing and deep stamping. Different heats of steel differ, often very decidedly, in their behavior in deep drawing and the behavior of a given lot will often change within a month or so as it ages upon standing. The exact mechanism of this aging has not been fully demonstrated although it is evidently only one aspect of the general phenomenon of aging in metals which has recently received so much study and which is believed to be a form of "precipitation hardening" and to vary with the degree of cold working the sheet has received. It is important to note that "non-aging" sheet steel has been developed and is now commercially available in this country. This is presumably of the same general nature as the German Izett or non-aging steel which has been available for several years and concerning the preparation of which great secrecy has been maintained. Another important engineering advance in which aging of steel plays a part is the clarifying of the situation concerning the embrittlement of galvanized structural steel transmission-line tower members. Punching of holes in heavy bars of ordinary steel may result in embrittlement, whereas non-aging structural steel (unfortunately not yet commercially available) is not susceptible.

Steel containing copper, 0.7 to 1.5%, can be greatly improved in its properties by an aging treatment. The yield strength and ultimate tensile strength can be raised 30%. Although not yet a commercial material, this accomplishment is evidently another indication of



Hard-facing a 9" valve disk for high temperature, high pressure steam service (Courtesy Haynes Stellite Company)

In the Aston Process, the sponge ball is dumped on the platform of the 900 ton electrically driven press (Courtesy A. M. Byers Co.)

other advances in the improvement of ordinary steel. It appears especially applicable to castings.

Another marked trend in this field is the addition of relatively small amounts of alloying elements, usually several, to a low carbon steel, to increase the strength properties, especially yield strength, and/or the corrosion resistance. Typical examples are: medium-manganese steel (.35% C, 1.25-1.75% Mn) having a yield point, 60-75,000 lbs./in.^{2}, ultimate tensile strength, 85-95,000 lbs./in.^{2}, elongation (2 inches), 20-25%, used in the Kill van Kull Bridge. The addition of a small amount of vanadium further improves the strength properties without any loss in ductility; "Cromansil" (0.31% C, 0.44% Cr, 1.10% Mn, 0.60% Si) which has a tensile strength 66% higher, and a yield strength 80% higher than corresponding unalloyed structural steel without any increase in ductility; 5% Cr steel (0.20% C) which has found wide use in the petroleum refinery; and "Corten" (C 0.10%, Si 0.50-1.00%, Cu 0.30-0.50%, Cr 0.50-1.50%) for which is claimed an increase in yield point of 70%; in ultimate tensile strength, 50% and approximately 100% in resistance to atmospheric corrosion over the correspondingly simple copper-bearing open hearth steel.

One cannot properly evaluate on paper the accomplishments of the extensive coöperative studies on steel-making under Dr. Herty, just completed. Valuable as is the wealth of information revealed, the intimate incorporation of this into the practical routine of steel-making which has been going on constantly is far more important. One important tangible achievement to be mentioned is the commercial availability of a special grade of "super clean" steel by some of the coöperating companies.

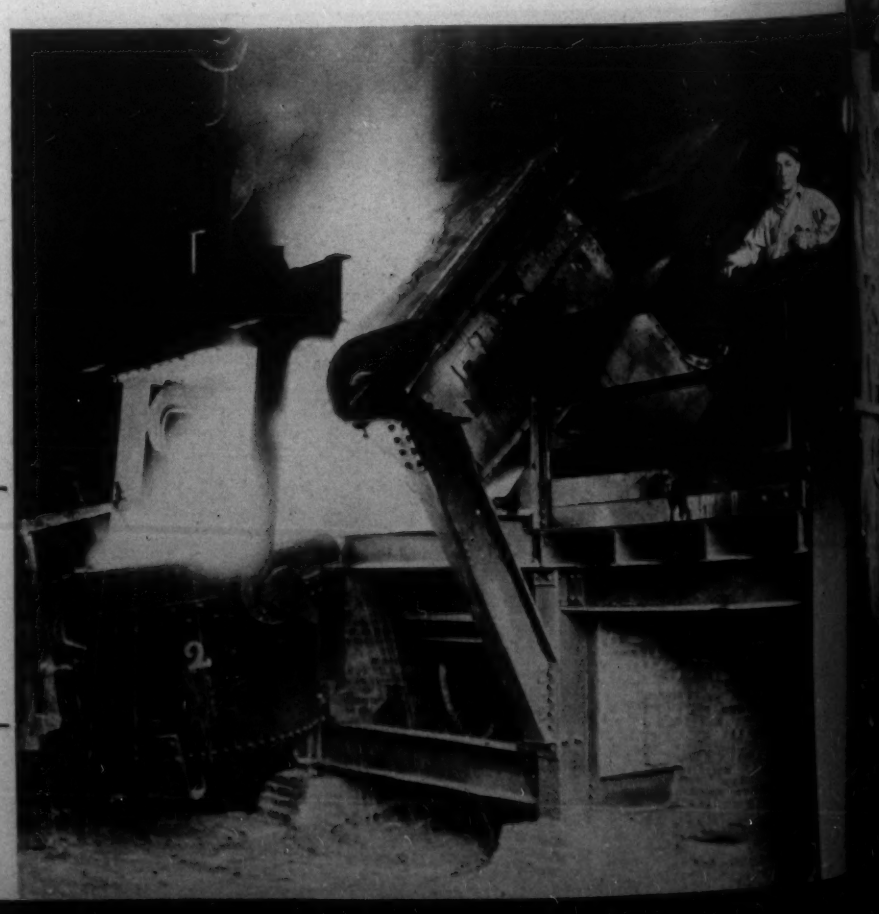
Metal-Cutting Steels

Of numerous attempts to improve existing high-speed tool steels only a very few are really outstanding. Steels high in Co have definite merit particularly for their "fool proofness" in hardening and steel containing Mo as the principal constituent together with a suitable proportion of W has found a definite place commercially. Likewise the marked improvement which can be obtained by the use of V should be mentioned. 'Sykes' new metal-cutting alloy of Fe-W-Co, one of the rapidly increasing class of materials responsive to precipitation-hardening, is an important newcomer in the field and can confidently be expected to make a definite place for itself as have the sintered-carbide tools the range of which has been widened recently by the use of tantalum carbide as the basic material. In general, however, the well known "18-4-1" type of steel is still head and shoulders above all its competitors combined for commercial high-speed cutting. In the carbon tool steel field recognition of the fact that these steels differ in "personality" has led to definite advances in this class of cutting steel.

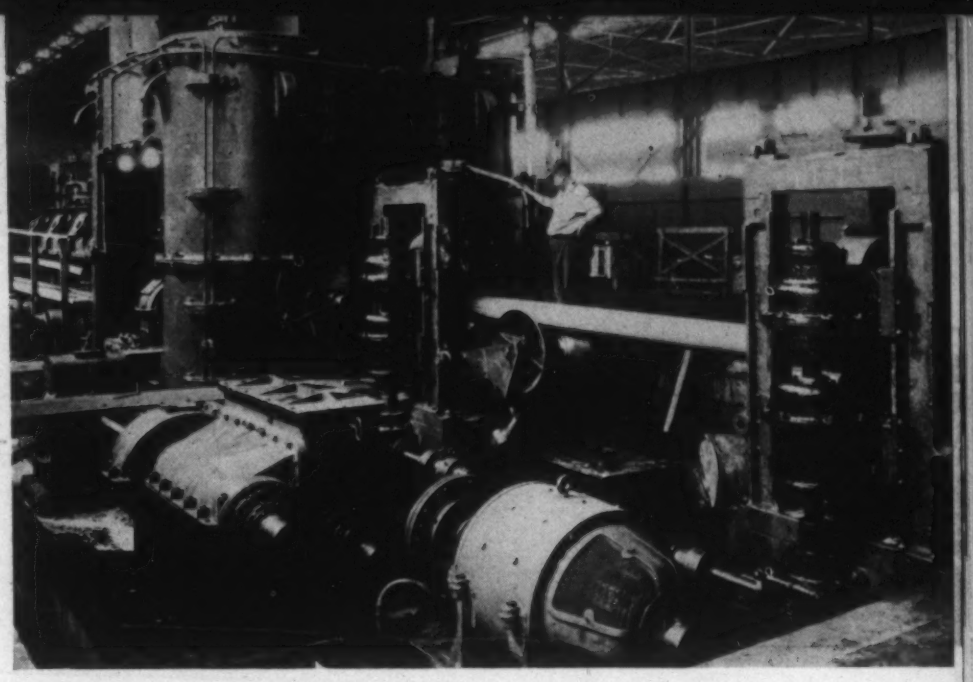
Cast Iron

Six years ago when the writer was interested in a new automobile, a point strongly emphasized by the representative of the car which was subsequently purchased, was the high-strength wear-resistant Ni-Cr cast iron cylinder block. The forward strides in cast iron manufacture in the few years since have been so remarkable that this argument would today carry little weight for sales purposes.

Gray cast irons having tensile strengths up to 60,000 lbs./in.^{2} are available commercially and are now covered in specifications by the American Society for Testing Materials. Although the irons having the highest strength properties may contain some alloying elements, it is not difficult to attain a tensile strength of 40,000 lbs./in.^{2} in an unalloyed cast iron. High-strength cast iron, such as Ni-Cr and Cr-Mo, may have a tensile strength well above 70,000 lbs./in.^{2} Alloyed with chromium alone, cast iron is "self-chilling." The alloying of cast iron has been carried to a point such that the product is used for purposes undreamed of 5 years ago. The cast automobile crankshaft (C, 1.25-1.40%, Si 1.90-2.10%, Cr 0.35-0.40%, Cu 2.50-2.75%, heat treated after casting) is an outstanding example of the new applications for this material. Another development of recent years, austenitic cast iron (Ni 14%, Cu 5.5%, Cr 3-6%, Si 2% and C 3%) is equally



The Ajax Electric Furnace at the South Chicago Plant of the Illinois Steel Company (Courtesy Ajax Electrothermic Corporation)



A length of 8-inch pipe after passing through the welding machine. The two roll stands check on straightness and roundness of the pipe section (Courtesy Republic Steel Corp.)

remarkable, especially for its superiority for high temperature service and for its corrosion-resistance.

The pressure-casting of cast iron by commercial die-casting methods is a commercial success and is being used constantly for producing certain shapes. Removal of the casting from the split mold before complete solidification has taken place is essential for success.

Malleable cast iron has not lagged behind other forms of iron. Short-time malleablizing processes have been perfected so that the time required is expressed in hours more appropriately than in days. Heat treated malleable cast iron with a tensile strength well over 75,000 lbs./in.^{2} and an elongation of 15% is regularly produced. The heat treatment of cast iron in general, of course, is not new. Its importance now is much greater, however, not only for alloyed iron but for the plain iron and is especially adaptable for iron of pearlitic matrix.

The surface-hardening of cast iron and malleable iron by nitriding is now a commercial success, the hardness of the case approaching that of nitrided steel. The composition of the iron must be modified by the introduction of aluminum and chromium to render it satisfactory for this treatment.

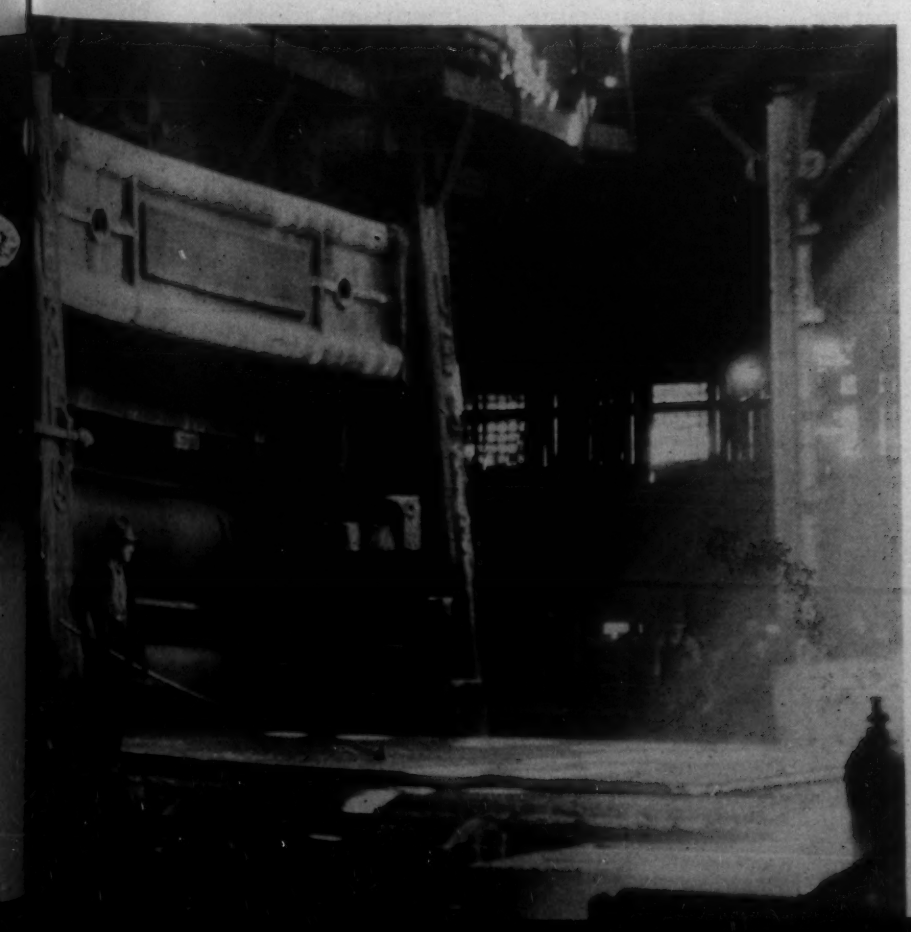
Coatings and Corrosion

Very valuable information on the useful service life of steel has resulted from extensive exposure tests, now reaching their culmination. Bureau of Standards tests have established the fact that the character of a soil is usually a far more potent variable determining the life of buried structures of ordinary ferrous materials than composition differences of various materials. Tests conducted by the American Society for Testing Materials on galvanized products exposed continuously to the weather in different localities have strikingly demonstrated the differences in the service life of coatings of different weights and also the need for choosing the weight to suit the prevailing service conditions, marine, industrial, rural, etc. Similar information on the merits of electroplated coatings is now available also.

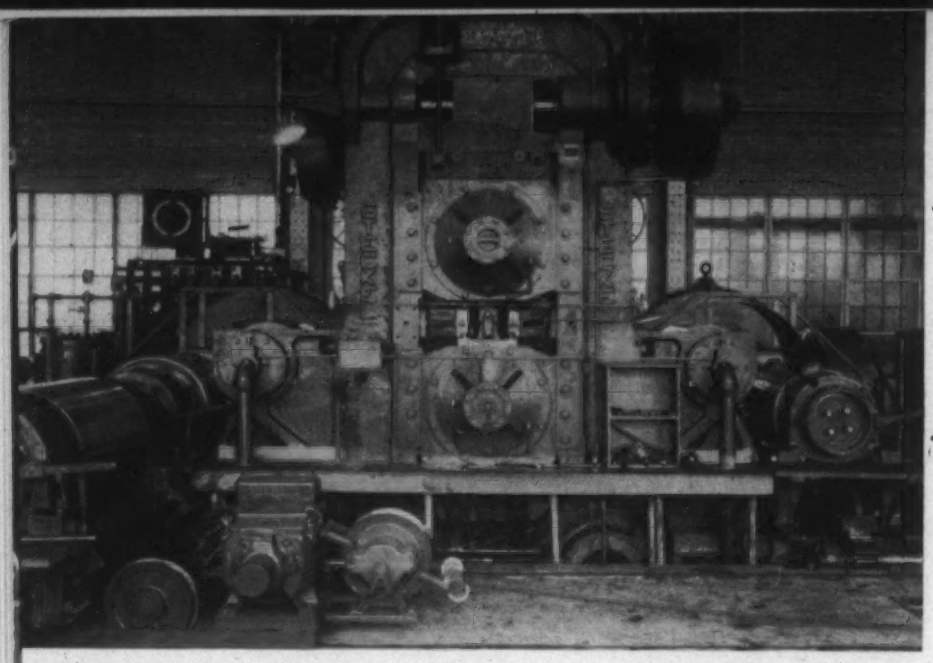
In the coating industry, itself, the adaptation of zinc plating to wire so as to give very heavy ductile coatings is now commercially feasible. The process is analogous to that used in electrolytic refining, that is, use is made of insoluble anodes, high current density and acid solutions. The successful application of the process in coating sheets as proposed would, indeed, be a remarkable and far-reaching accomplishment. The utilization of electrolytic pickling accompanied by the deposition of a thin flash of lead plating as a "finish" is the outstanding development in the pickling industry. The nearest approach to forming a satisfactory "natural" or oxidized coating on steel has continued to be the phosphate treatment which constitutes an excellent priming treatment before painting. The use of this by automobile manufacturers is ranked by them as a "materials" development of outstanding importance. If the simplified nitriding treatment applicable to *ordinary* steel and consisting in passing freshly prepared nitrogen through a molten salt bath continues to meet expectations, it should increase greatly the commercial usefulness of this treatment, the commercial development of which has not been in keeping with its spectacular beginning.

Heat Treatment

The most promising innovation in heat treatment technique is that resulting from the quenching studies of Bain and Davenport—interrupted hardening, a method also viewed with favor in Germany. The hazards of internal microscopic hardening cracks, distortion and high internal stresses can be very materially reduced by this means. The marked increase in the application of a controlled neutral atmosphere especially for annealing is likewise striking. The use of the coreless induction heating for heat treatment has passed the experimental stage and can confidently be expected to make marked progress especially for small high-grade products. In one of the large automobile plants in Detroit this method is now in production use for drying steel parts after coating instead of the conventional oven.



The 206-inch plate rolling mill at Coatesville, Pa. (Courtesy Lukens Steel Company)



A 38-inch Steckel Mill, the largest built to date (Courtesy Cold Metal Process Company)

Working of Steel

Although the working of steel is more of a mechanical achievement than a metallurgical one, mention will be made of some outstanding advances since the usefulness of any metal is determined in large measure by the readiness with which it can be put into useful shapes. The introduction of the successful continuous process for the hot rolling of steel sheet and strip slightly antedates the period covered by this review. However, its immediate widespread adoption by the large sheet steel companies plainly shows the present course of evolution in the rolling industry. Likewise, the introduction of the Steckel process for the cold rolling of continuous strip marks a notable achievement. In this method, the metal is reduced by *pulling* it between two rolls of relatively small diameter, each of which is backed up by a massive heavy roll. The reduction which may be accomplished without annealing, the accuracy in gage and the perfection of surface finish of the completed strip is almost unbelievable to one familiar only with the older conventional methods. The successful rolling of plate in widths up to 195 inches is also a remarkable accomplishment.

A process for the cold reduction of steel tubing, the Rockrite process, in which compressive stresses rather than tensile stresses are utilized, offers great promise though not yet in wide commercial use. A reduction of 35 or 40 times may be accomplished by the method without intermediate annealing as compared with reduction of 2 or 3 times by conventional cold drawing. The reduction is accomplished in short lengths at a time by a reciprocating rolling between properly shaped rolls. Mention has already been made of the great inroads which electric welding has made in pipe manufacture by the older and more conventional methods.

A recent British process for the direct rolling of weldless chain easily qualifies as a "believe it or not" entry. The essential requirement is a cruciform shaped bar as the initial stock from which the links are rolled by two pairs of rolls working at right angles to each other.

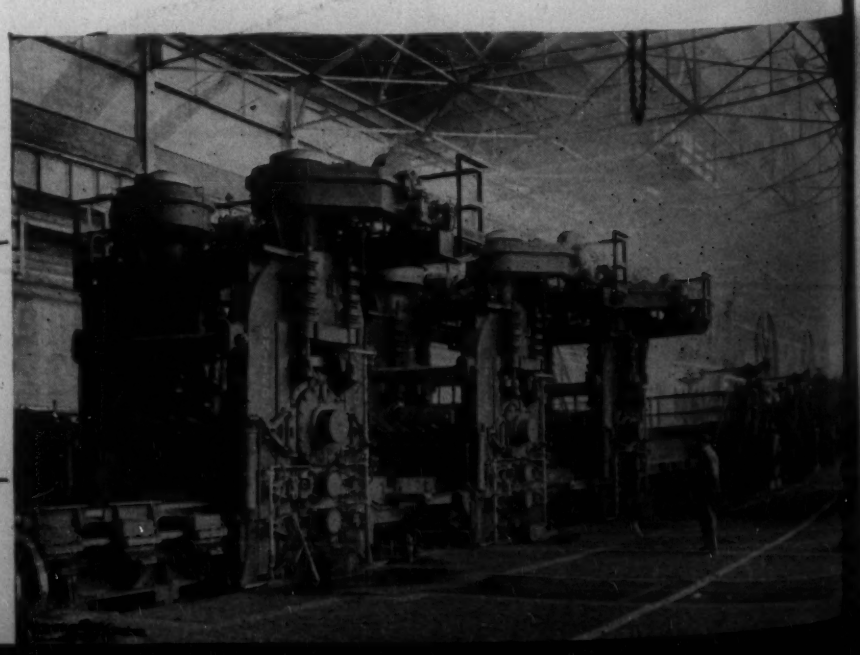
Melting

The advance in the use of the coreless induction furnace for melting merits special mention, the total kw. used having increased 80% since 1931. A unit melting 8500 lbs. (1200 kw. 960 cycles) in slightly more than 2 hours by the Illinois Steel Company holds the record up to date in the United States. Several 5-ton furnaces have been installed in Europe and plans for a 7-ton unit are under way. An adaptation of the furnace for using a liquid charge adds materially to the already great rapidity with which heats can be turned out.

Current reports that a German plant is ready for vacuum melting on a commercial scale would seem to indicate that we are surely, though slowly, nearing this ideal method of steel making.

Technical Information

The wonderful additions which have been made to our store of metallurgical knowledge in a fundamental way and the advances in testing technique and methods have not been included in this review. While a bibliography of the metallurgical accomplishments of the past five years is impracticable and would probably serve no very useful purpose here, mention should be made of several publications summarizing information along certain lines. Information of the right sort which is readily accessible in usable form can well be classed as "engineering" material. Joint symposia held by the American Society for Testing Materials and American Foundrymen's Association on Cast Iron, on Malleable Iron and on Steel Castings are outstanding, together with the Joint Symposium by the American Society of Mechanical Engineers and American Society for Testing Materials on the Effect of Temperature on Metals and the American Society for Testing Materials Symposium on the Weathering of Metals. Noteworthy also are the available monographs of the Alloys of Iron Research Committee, of Engineering Foundation, dealing with alloys of iron with silicon, with tungsten, with molybdenum and with copper. The completion of the volumes covering iron and its other industrial alloys will constitute an outstanding source of information on iron and steel which, for scope and reliability, has not yet been equalled.



Armco's Continuous Mill making a ton of sheets per minute (Courtesy American Rolling Mill Company)

The Battle Deck Floor of Aluminum Plate and Structural Shapes on the Highway Side before laying the floor on the Smithfield Steel Bridge, Pittsburgh, Pa. (Courtesy Aluminum Company of America)

NON-FERROUS METALLURGICAL DEVELOPMENTS

During the Past Five Years

By Sam Tour*

THE PAST five years have witnessed an increasing development in the fabrication and application of non-ferrous metals and alloys. The metals, with their alloys, which are leading in this development are aluminum, copper, lead, magnesium, nickel and zinc. Considerable research and development work on these metals has been done and is now being carried along. Fruits of some of this research work have become apparent in semi-commercial and commercial manufacture and application.

Aluminum and Its Alloys

Aluminum and its alloys because of their lightness are finding increased uses in the field of transportation, in railroads, trolleys, buses, airplanes and airships. Many of these applications could have been made earlier but the large structural shapes required were not available. The erection at Massena, New York by the Aluminum Company of America of a structural mill capable of producing structural shapes 14 inches in depth and 90 feet in length from strong heat treated aluminum alloy has made commercially available the parts necessary for many of these applications.

Outstanding examples of the increased use of aluminum in railroad rolling stock are the streamlined articulated train for the Union Pacific lines, a five-car subway train built largely of aluminum alloys, two all-aluminum Pullman cars each weighing slightly less than half as much as an all steel Pullman car of similar design.

In the field of aeronautics the three outstanding examples of the increased use of aluminum have been in the construction of ZMC-2, the Akron and the Macon. In the construction of the ZMC-2 Alclad sheet was used in place of fabric as a covering for the aluminum framework. The Alclad sheets were sewed together by a riveting machine developed especially for this job.

* Lucius Pitkin, Inc.

The Akron and the Macon were constructed with fabric for a covering but the framework was built from a duralumin alloy 17S.

Outside of the transportation field aluminum alloys have found increased use in overhead cranes and in bridge construction. Attention has been directed to the use of aluminum alloy structural shapes and plates on the floor of the Smithfield Street Bridge over the Monongahela River in Pittsburgh. The load on the trusses has been reduced by about 750 tons prolonging the useful life of the structure at least 25 years.

A development of practical importance is that of retarding the age hardening of some of the aluminum alloys by keeping them in cold storage. Dry ice containers have been used successfully.

The use of aluminum foil for thermal insulation has been developed and is finding great application.

The use of aluminum foil for wrapping foods has been developed and considerable activity along this line is to be expected in the future.

Aluminum is quite resistant to atmospheric corrosion and castings do not require painting to preserve them. It, therefore, is finding an application in the architectural field in the form of ornamentation of buildings. Outstanding applications in this line have been on the Chrysler Building and the R. C. A. Building in New York City, and on the Cathedral of Learning in Pittsburgh.

Due to its resistance to hydrogen sulphide aluminum is finding a use in oil refineries where the oils are free from moisture. Large all-aluminum storage tanks have been made and have proven satisfactory. It is also being used for oil refinery pipe lines, condensers, etc.

The process of coating aluminum by anodic treatment has made considerable technical and commercial progress. Processes have been developed for increasing the resistance of the oxide coating to attack by fruit juices, cleaning solutions and so forth. Processes have also been developed which make the oxide

The Five-Section Car of the Interborough Rapid Transit Corp. Bodies and Trucks of the Cars are built of Aluminum. (Courtesy Aluminum Company of America)

coating immune to stain by coffee, ink and other colored liquids. A new surface treating process for polished aluminum makes possible its use in reflectors.

Among the number of new aluminum alloys which have been developed the more important are 4S and 53S of the Aluminum Company of America and the alloys of aluminum having magnesium as the principal alloying element.

Copper and Copper Alloys

Considerable attention has been given to the problem of gas absorption and the effect of small amounts of impurities in copper and its alloys. Attention has also centered on the deoxidization and degasification of copper and copper alloys by means of alkali and alkali earth metals. A detailed study of bearing bronzes has been made at the Battelle Memorial Institute.

Five outstanding developments in regard to copper and its alloys have been:

1. The commercial development of oxygen free high conductivity copper.
2. Increased knowledge, development and use of the copper silicon alloys.
3. Commercial development of the copper beryllium alloys.
4. The commercial development of the die casting of brass, and
5. The swaging of tubing.

Oxygen free high conductivity copper is being produced by one or more of four different methods: by melting under controlled reducing atmospheres, by sintering solid cathode particles under controlled atmospheres, by using lithium as a deoxidizer of the molten metal and by the use of copper with low phosphorus content as a deoxidizer.

Oxygen free high conductivity copper is now available in practically all commercial forms and sizes. Indications are that in time these coppers will largely replace the old tough-pitch materials for many applications.

From a great number of copper silicon alloys which have been and are being studied in the research laboratories some have emerged and are now commercially available. These alloys are high strength alloys and have characteristics similar to the original Everdur. Among these may be mentioned Herculoy, Olympic Bronze, Cusilloy, Duronze, Tombasil, and P. M. G. Bronze.

The copper beryllium alloys have developed more in the wrought forms than in the cast form. An alloy containing about 2% of beryllium is the most popular at the present time. Heat treatment of these alloys produces exceptional strength and hardness. Modified copper beryllium alloys containing a third metal may be expected soon. A further development of copper beryllium casting alloys may also be expected.

The die casting of brass which received its original impetus in Germany has been transplanted to the United States and developed to a point where brass die castings are now commercially available.

A process of swaging tubing instead of extruding and/or drawing has been developed and may find a particularly good field for the aluminum brasses and the copper-nickel alloys.

The bright annealing of copper and brass in controlled atmospheres has become an economical and practical process.

The use of copper tubing with sweat fittings for general plumbing purposes has considerably increased. This has been found ideal for such uses as oil lines, air lines, refrigerator lines, heating lines and vacuum lines.

An interesting development for the use of copper has been copper molds and copper mold stools for casting steel. Copper mold stools have been demonstrated to be satisfactory and their use is now increasing.

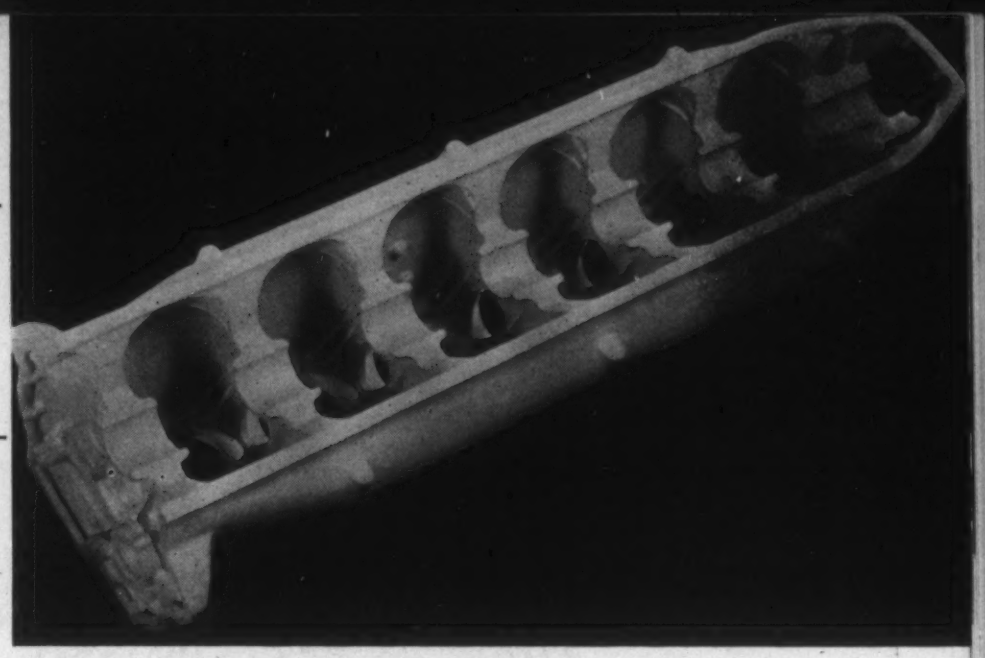
The production of electrodeposited copper sheet, strip and foil on a commercial scale has been accomplished.

On the verge of commercial application is the process of casting relatively thin sheet between slowly revolving rolls. This will eliminate some of the earlier steps in producing sheet and strip. This process may also have possibilities in the production of tubing.

A development which should have far reaching results has been the adoption of an active and comprehensive research policy by the Copper and Brass Research Association.

Lead and Its Alloys

In regard to lead and its alloys considerable attention and work has been devoted during the last five years to developing alloys for use as a cable sheathing. Particular attention has been given to the alloys of lead with calcium. It has been stated that "A lead-



Magnesium Crankcase for Aircraft Motor by Wright
(Courtesy Dow Chemical Company)

calcium alloy has been developed which has a very high fatigue strength. That is, it is very resistant to failure from reverse stresses, and it is finding a wide usage as cable sheathing." Work on this problem has also been carried out on alloys of lead-antimony-cadmium and lead-tin-cadmium. An alloy of lead and lithium has also been proposed for this purpose.

The use of lead in anodes for the electrolytic production of high grade zinc has been mentioned previously. These anodes contain 98.8% lead, 1% silver and 0.2% arsenic.

Experiments have been conducted to find out the value of using lead as a cushion between the rails and the ties on railroads. A firmer embedding of the rails may be expected and also a deadening of the sound or "ring" of the rails as the trains pass over. Along this same line installations have been made of lead mattresses under machinery and buildings to absorb vibrations.

A comprehensive work has been carried out by the Bureau of Standards on lead in bearing alloys and in lead base babbitts.

Lead is being used in increasing quantities as a protective coating on other metals, wood, brick, concrete, etc., being applied by means of a sprav gun. Interest has also been shown in the impregnation of wood by immersing in a lead bath and applying pressure so as to force the lead into the pores.

Considerable work has been done and tests have been made to increase the knowledge of the static and dynamic properties of lead and lead alloys.

Of recent date considerable interest has been shown in the alloys of lead and tellurium. Less than 1% of tellurium is used. This addition has a marked effect upon the physical properties and increases the resistance to corrosion in concentrated sulphuric acid. It has been found that extruded pipes of this alloy, when filled with water and frozen, will withstand five freezings before bursting as against two freezings before burstirg for ordinary lead.

Magnesium and Its Alloys

An outstanding development of the last five years has been the rapid growth of the magnesium industry and the commercial availability of magnesium base alloys. Magnesium alloys are now commercially used in sand castings, die castings, forgings, structural shapes, plate, sheet and strip.

Due to its extreme lightness it finds many uses in aircraft as for engine crankcases, starting equipment, instrument housings, landing and tail wheels, etc. Its use as the material for the gondola of the stratosphere balloon has received much publicity.

Its uses are increasing in other fields of transportation, in portable tools, machine parts, foundry match-plate patterns, household and office appliances, etc.

Chemical treatments have been developed to prepare the surface for protective paint coatings. Methods of producing colored finishes and dye treatments have been developed.

The developments, both technical and commercial, of magnesium and its alloys have been extremely rapid in the last five years and it is expected that this activity will continue for some time to come.

Nickel and Its Alloys

Noteworthy among the developments in nickel and its alloys during the last five years has been the enlarged production of high purity electrolytic cathode for use in alloy steels and nickel alloys. Thus nickel of a higher purity than that obtainable from furnace methods is now commercially available.

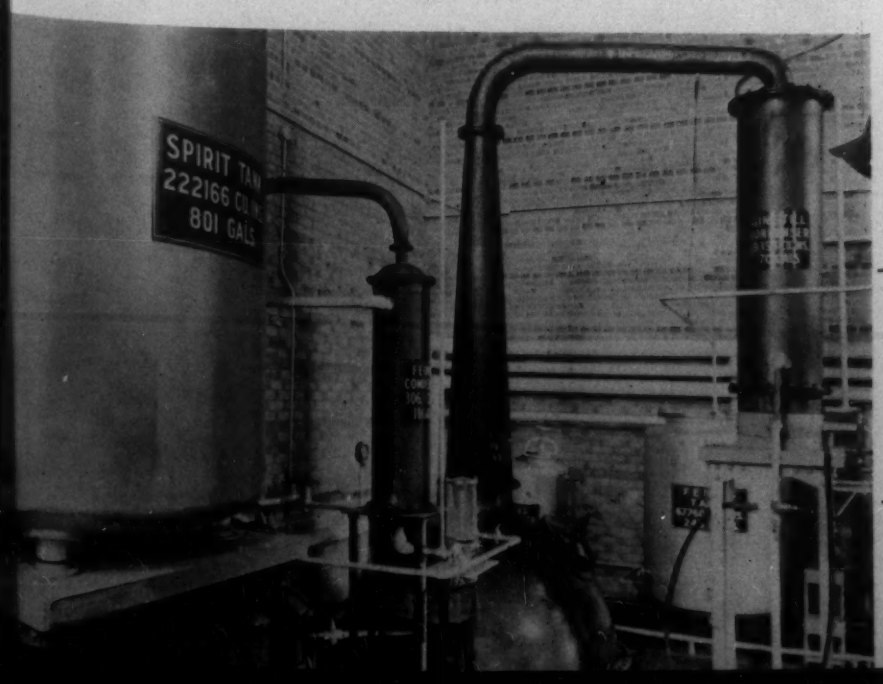
Technical and commercial developments have increased the application and uses of stainless steels of the 18% chromium and 8 to 10% nickel type.

Monel metal retains its place as the most widely used of the high corrosion-resisting nickel alloys. It has been introduced into the household for such articles as kitchen sinks, tables and drain boards and architectural metal work. It has also found applications in food handling, soda fountains, chemical uses, electric equipment, laundry machinery, dyeing machinery and so forth. Centrifugally cast monel metal tubes and sleeves are now obtainable.

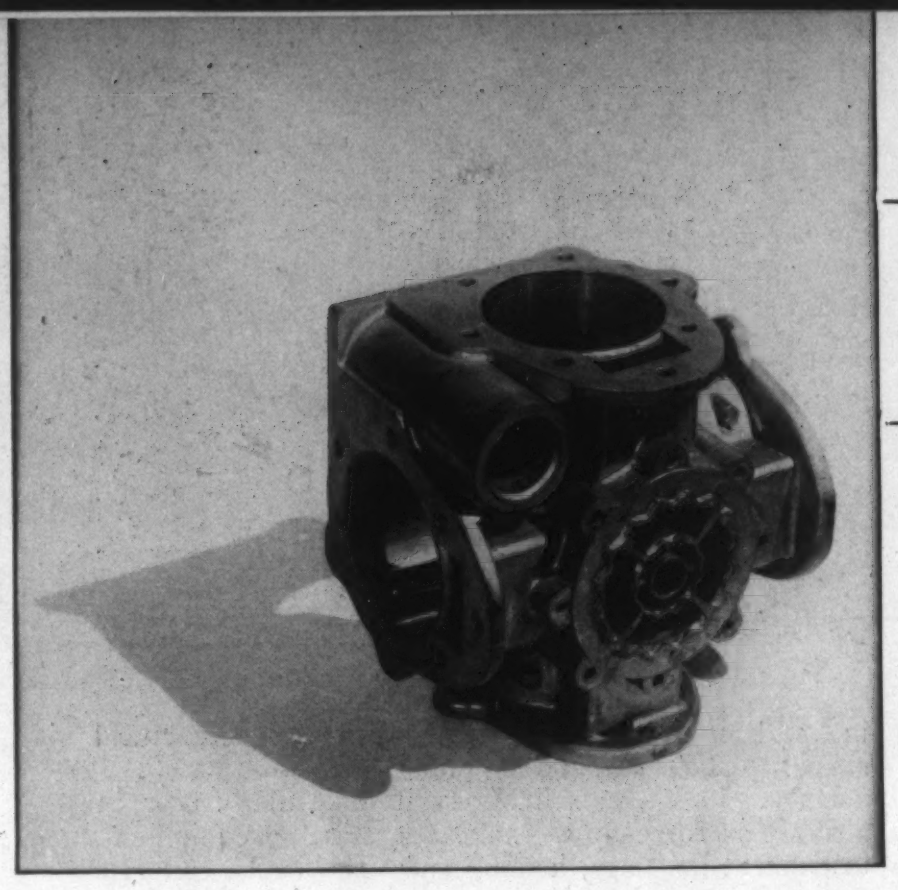
Commercially pure malleable nickel has increased in use, being used in the evaporation of caustic soda, in tanks for handling caustic soda, in milk plants, etc.

A new nickel-chromium-silicon-iron alloy has been developed which is resistant to sulphuric acid as used in metal pickling processes.

The use of copper-nickel condenser tubing in marine work has had considerable growth.



Inconel Tanks in the Gin Plant Distillery of W. & A. Gilbey, Ltd.
(Courtesy the International Nickel Co., Inc.)



Zinc Alloy Die Cast Pump Housing for a Wayne Gasoline Pump
(Courtesy New Jersey Zinc Company)

The ferro-nickel alloy "Elinvar" which maintains a constant elasticity with changes in temperature, has found a use in the balance springs of watches.

A technical development has been the application of the principles of precipitation hardening to nickel base alloys.

Zinc and Its Alloys

Improvements in zinc and its alloys during the last five years have followed along four main lines: The commercial development of high purity zinc, developments in alloys and technique in die casting, work on galvanizing and the development of alloys for rolled zinc products.

The commercial availability of high grade zinc has been outstanding in forming new outlets for the use of zinc alloys, particularly in the die casting field. High grade zinc has a purity of 99.99+% zinc. Lead content of a maximum of .007% is now regularly specified and most of the material actually contains less than .005%. It is now reported that zinc of 99.995+% purity with lead under .002% can be had in quantity.

In addition to aiding the use of zinc in the die casting industry, high grade zinc has opened up possibilities in the extrusion, wire, brass, dairy and pharmaceutical fields.

The low percentage of impurities has increased the ductility and the passivity to acids. The analysis is closely controlled and is uniform, being done much more simply and rapidly by the spectrograph than by chemical analysis.

The use of zinc base alloys in the die casting industry has increased enormously in the last five years, due in large part to the use of high grade zinc. The number of alloys used has been substantially reduced and are covered by A. S. T. M. specifications. The copper free zinc base alloys is superseding the zinc alloys with copper in many cases because of its better dimensional stability and its retention of impact strength.

Improvements in the mechanical technique of die casting have also aided the increased use of zinc base alloys, making possible the use of thinner sections and improving the surface appearance. Improvement in stability of the alloys is bringing an increasing use of larger and heavier castings.

As the galvanizing field continues to be the greatest consumer of zinc, it naturally follows that considerable attention and research work has been devoted to it. A study of the embrittlement of steel during the hot galvanizing operation carried out at the Battelle Memorial Institute has shown that this embrittlement is due to the temperatures to which the steel is exposed and also that this can be avoided.

The American Zinc Institute has been active in a program of educating users of galvanized products that better results are obtainable by the use of heavier zinc coatings. Heavier coatings have been developed on a commercial scale by the Tainton process of electrogalvanizing. Coatings are produced which have good adherence and ductility and do not flake even with considerable deformation. This process uses high current density and the zinc is furnished to the electrolyte by the solution of ore instead of the solution of anodes. Coatings of greater resistance to peeling have resulted from annealing of hot galvanized wire.

In the field of rolled zinc the use of zinc alloys with a small percentage of copper has increased. The copper bearing alloys give strength without sacrificing drawing and bending qualities. Used in corrugated form as a roofing material they allow the support spacing to be materially increased.

An increase in the width of sheets that may be rolled has also been a development of the past five years.

An important development from the standpoint of zinc production has been the method of producing from vertical continuously operated furnaces instead of from horizonal retorts and improved methods of condensing the zinc vapor.

Zinc Die Cast Parts of a Hair Waving Machine
(Courtesy New Jersey Zinc Company)

An All-Aluminum Transport Plane of the Transcontinental & Western Air, Inc. speeds up schedules
(Courtesy Aluminum Company of America)

METALLURGICAL ADVANCES Reflected in Engineering Design

By Robert W. Carson*

WELL-DESERVED credit belongs to those designers who have been willing to break with tradition in developing new high-speed trains and airplanes, modern automobiles and skyscrapers. But as every designer knows, these popularized engineering achievements do not tell the whole story. Much remains to be told about the metallurgical research that developed new engineering metals, while many developments of much greater importance lack popular recognition.

Not so well publicised but of great significance has been the design of equipment to withstand higher temperatures, making possible new processes and improved efficiencies. The public little appreciates the great strides made in the past five years in increasing speeds of operation and improving reliability of machinery through the use of alloy steels now available at reasonable cost. The Empire State Building has popularized one application for stainless steel; but the use of this metal in chemical and food industries has had a much greater effect upon our daily lives. Strong alloys lighter than aluminum have played an important part in the design of new record-breaking airplanes; of even more significance is the use of high-strength steels to reduce weight in all types of power machinery.

In the past five years a variety of high-strength alloy steels have been developed into commercial engineering materials. Steels containing nickel, chromium, molybdenum and vanadium are extensively used for highly-stressed parts that must be tough and ductile. Automobile and truck axles, ring gears and pinions, and steering knuckles; drive shafts, gears and linkages in power presses, cranes, power shovels and machine tools are but a few typical applications. Crankshafts and connecting rods made of low-cost high-strength nickel and nickel-molybdenum alloy steels add to the power output and decrease vibration in airplane, automobile and diesel engines. Low chrome-nickel steels for large electric motor shafts provide added strength and toughness to withstand shock loads encountered in rolling mill drives. Chrome-nickel-molybdenum steels give greater strength needed for tie rods used in built-up generator rotors. For parts in textile equipment, paper machinery and printing presses, machine tools, construction machinery and locomotives the same advantages are obtained in the use of modern high-strength alloy steels.

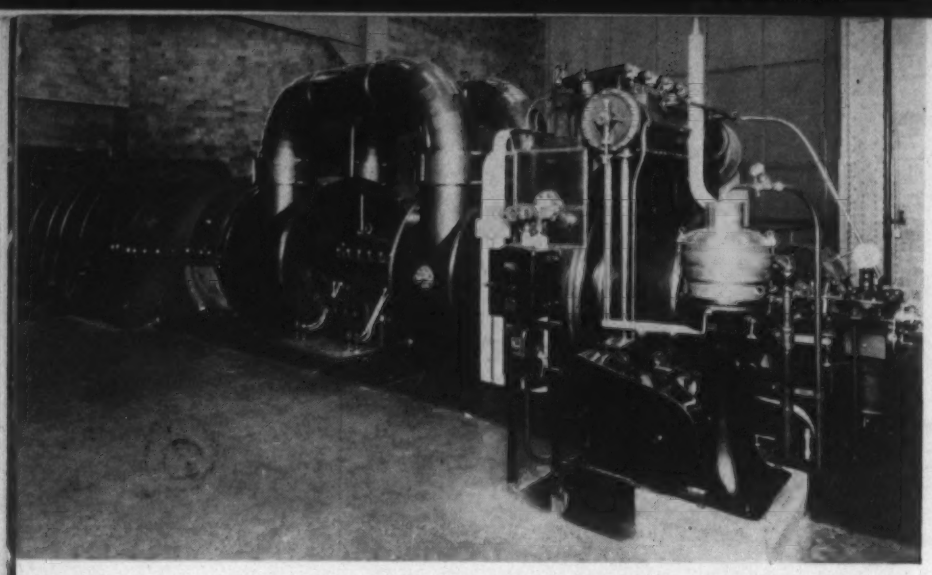
By permitting the use of high working stresses, chrome-vanadium steels make safe and serviceable parts for light-weight applications in aircraft and railcar frames and railcar trucks. In addition to being light in weight, these structures also are stiff and rigid because of the high elastic modulus of steel.

Recently developed high-strength casting alloys make possible large economies in the manufacture of parts that must be of irregular shape. The use of cast crankshafts and camshafts in automobile engines not only eliminates forging expense and much machining, but also allows the use of a material having a higher damping effect on torsional vibrations. Higher rotating speeds permissible with centrifugal baskets cast from a 5% chromium steel illustrate the possibility of increasing machine performance through the adoption of higher working stresses. And in this application, the greater corrosion resistance of the alloy is an added factor favoring the selection of a more expensive material.

The high strength of cold-worked stainless steel has likewise led to its application as a material for light-weight construction. No allowance is required for rust or corrosion, and no added weight is necessary for surface protection. Methods of electrical resistance welding, recently developed, permit the design of complicated structures and special shapes adapted to the load each part carries.

Several high-strength non-ferrous alloys not available five years ago are now successfully used in many engineering designs. A remarkable development in age-hardening copper alloys provides designers with a material having all the desirable properties of phosphor bronze; yet, the material can be shaped and formed in the soft condition, and then heat-treated to develop strengths common to alloy steels. For springs,

* Assistant Editor, Product Engineering.



In high-pressure turbine generators, chrome and chrome-nickel steels allow the use of steam temperatures as high as 1100° F. with consequent reductions in energy consumption

electrical conducting parts, airplane propeller hubs, worm gears, resistance welding electrodes and highly-stressed parts subjected to sea water and salt air, these heat-treated copper alloys provide greater reliability, compactness and resistance to corrosion. Tools for use in explosive atmospheres, when made of beryllium copper, hold sharp cutting edges and also eliminate danger from sparking.

High-strength copper-base alloys are also available for die casting, combining resistance to atmospheric corrosion with the inherent economies of the die-casting process. Low-cost die castings are now used for parts in dairy equipment, for outboard motor propellers, automobile hardware, pump impellers and valve disks, extending the advantages of the die-casting process to corrosion-resistant alloys having the strength of medium carbon steel.

To meet requirements of high strength at elevated temperatures, recently developed heat-resistant steels are now available combining toughness and resistance to creep. Low-cost carbon steels with 3 to 5% chromium and small amounts of molybdenum or tungsten have made possible the use of working temperatures above 950° F. in oil cracking stills and oil pumps. Similar alloys containing manganese and silicon in addition to chromium show a life of ten times that of carbon steel at temperatures of 1000° F. and higher. These heat-resistant alloy steels in boiler and turbine construction permit the use of steam temperatures above 1100° F. and pressures as high as 1200 lbs./in.^{2} Increased boiler and turbine efficiencies have accompanied increased life in units constructed of alloy steels developed for high temperature service.

Other alloys containing copper and molybdenum have also shown sufficient oxidation resistance and high-temperature strength to allow their use in oil refinery equipment, evaporators and pressure vessels. Turbine blading, impellers for hot oil pumps, and bolts for turbine casings and steam pipe flanges where high strength and creep resistance are essential requirements are now made of 12% chromium steel. These alloy steels not only increase the service life of high temperature equipment, but they also increase safety and reduce time lost in maintenance and replacement. And in high-temperature chemical processes, these alloys, in addition to their high strength, offer greater resistance to corrosion.

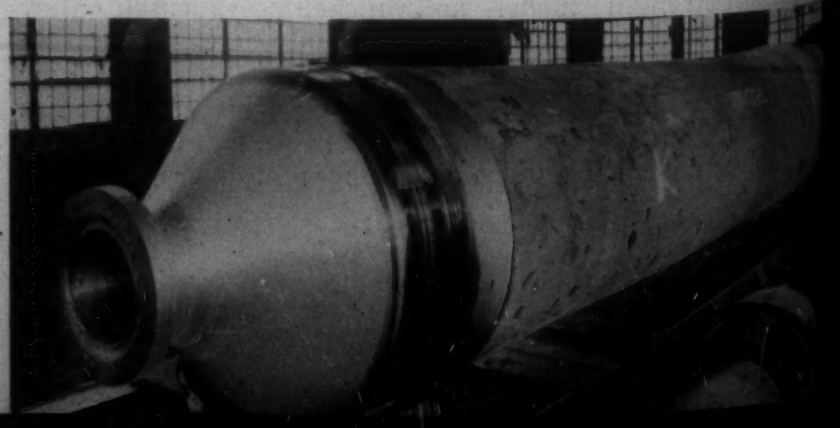
Recently developed alloys with increased corrosion resistance at normal temperatures have widely influenced the design of metal products in every field of engineering. The advances made during the past five years have been not so much in the discovery of new alloys as in the perfection of methods for producing existing alloys at an economical price. Added alloy elements have increased ductility and improved machinability.

In most industrial applications of these improved stainless steels, corrosion problems are of three types: preserving appearance, conserving the structure, and preventing contamination. In household appliances, automobiles, business machines, store fixtures and building exteriors the principal problem is to prevent oxidation of the surface. In high-speed railroad trains, water-wheel runners, chemical evaporators and structures exposed to sea water, rust and corrosion reduces the strength of steel parts. In food processing equipment, milk pasteurizers, rayon pumps, textile dyeing tanks and laundry machinery, corrosion products affect the quality of the materials handled. The extensive adoption of 18-8 stainless steel by designers is largely due to the ability of this steel to satisfy all three of the requirements.

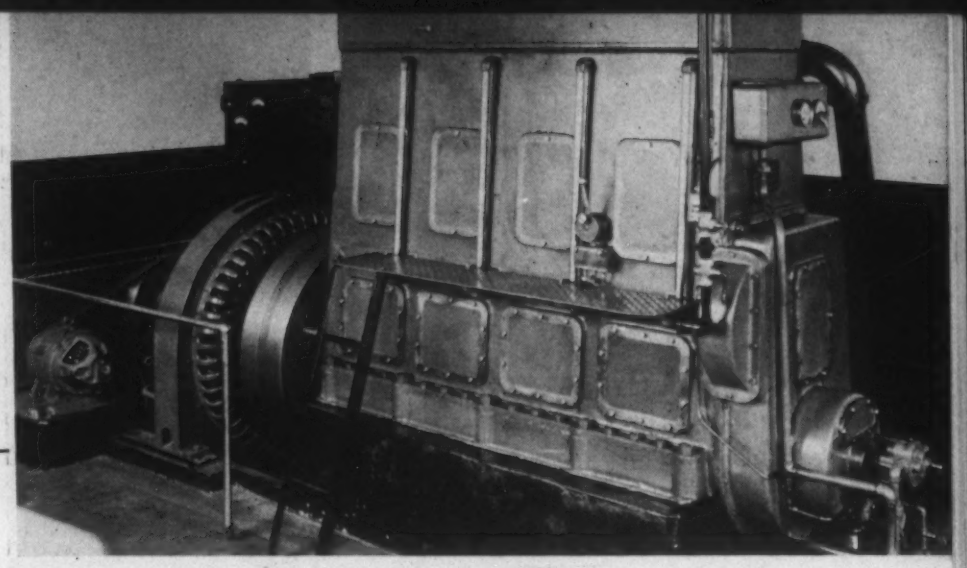
Aluminum as a corrosion-resistant material has found several new applications both for its maintenance of structural strength and the protection of materials from corrosion products. For example, in tank cars and tank trucks for transporting certain chemicals, aluminum makes possible a desirable reduction in dead weight in addition to resisting corrosion.

For applications requiring resistance to certain acids in various concentrations, a variety of alloys are now in use. Alloy steel castings containing up to 14% chromium, although difficult to machine, successfully resist the action of weak acids, particularly where high temperatures are involved. Heat-treated 18-8 stainless steel castings as well as alloys containing up to 25% chromium and 20% nickel are used for mixed acid conditions. In these applications, greater corrosion resistance more than offsets the higher cost of such special-purpose alloys.

To further reduce the cost of resisting corrosion in many applications, two-ply metals have been widely adopted. To carry the structural loads, a low-cost steel backing is used, protected from corrosion by a thin stainless steel face, only thick enough to provide the required protection. These cost-reducing materials have been extensively used in the design of tank trucks for transporting milk and in textile dyeing vats, reducing the cost of the structure while fully protecting the perishable products being handled. Another composite material widely used in the same field consists of a layer of pure nickel bonded to a backing of mild steel. Welding problems in connection with these two-



New processes and new economies in old processes result from increased temperatures in oil-cracking stills, requiring steels with greater high-temperature strength (Courtesy Bethlehem Steel Co.)



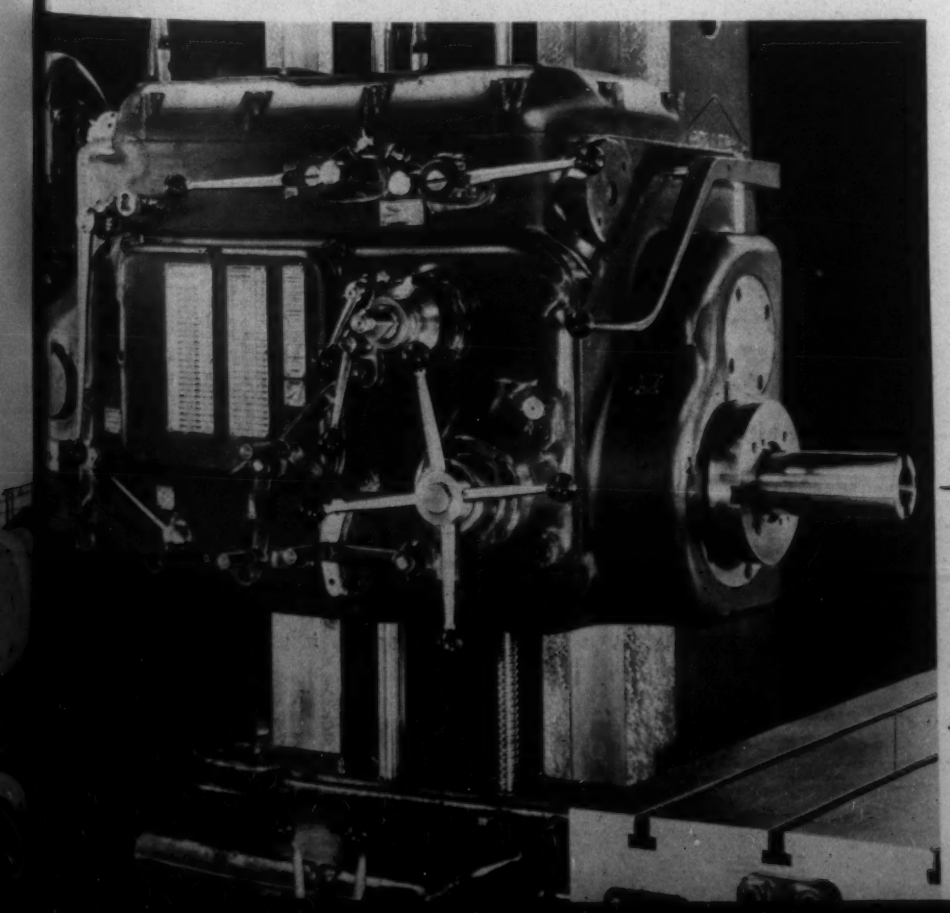
Nickel-steel and nickel-iron alloys in modern high-speed diesel engines reduce weight and increase the life

ply metals have now been solved, opening up many new applications.

Non-ferrous two-ply metals have also found many applications. Thin layers of pure aluminum on one or both sides of heat-treated duralumin sheets provide light-weight, high-strength structures resistant to atmospheric corrosion and the corrosive action of sea water. Many difficult problems in aircraft design have been solved by the adoption of these two-ply metals in airplane pontoons, spars, landing gears and fuselage sheets. And now, methods of resistance welding have been perfected giving joints that do not affect the corrosion resistance of the protecting surface.

Applications of aluminum alloys for the purpose of reducing weight have been greatly extended in the past five years, not so much through metallurgical advances as through a highly successful record of performance in the aircraft industry. Aluminum alloys have been responsible for a large reduction in the weight of railcars and high-speed trains, greatly decreasing power requirements. Aluminum and aluminum alloy sheets for exteriors are not only light in weight, but are readily formed, pressed or drawn to special shapes and contours demanded by streamline designs.

Reductions in the cost of producing magnesium during the last two or three years have led to widespread applications for light-weight parts, not only in airplane motors but also in hand tools, printing presses, buses, instruments and portable equipment of all kinds. In using magnesium alloys the low specific weight and the high strength per unit weight together have made possible the design of blowers and superchargers that operate at higher speeds than can be obtained with the use of any other metal. Lower bearing loads, smaller inertia forces and reduced power requirements are further design improvements obtained from the adoption of magnesium alloys in all types of power machinery.



High-strength cast iron and alloy steel provides added strength needed in machine tools using tungsten carbide cutting tools

The design of nearly every type of machine tool also has been influenced by the recent development of a series of hard-facing alloys. When used for the working edges of cutting tools, hard-facing alloys allow much higher cutting speeds, calling for increased machine speeds, stronger gears and shafts, more rigid machine beds and larger motors in milling machines, lathes and automatic tools. Other hard, wear-resisting alloys, deposited by welding, have improved the durability of construction machinery, rock crushers and turbine blades. Inserted valve seats for exhaust valves likewise have increased serviceability in automobile and truck engines.

As a hard-facing process, nitriding has been extensively used following the recent development of suitable steel and cast iron alloys. Pump shafts, elevator guides, cylinder liners, pump castings and valve plugs successfully resist wear under conditions of poor lubrication. Nitriding also decreases erosion in valves, cylinders and plungers for pumps handling liquids containing sand or silt.

The adoption of die casting for parts used in all kinds of machinery, household appliances, automobiles and a variety of other devices reflects recent advances in the development of alloys suitable for die casting. By better control of corrosion and aging, the use of zinc alloys has been greatly extended. New copper alloys have been developed that subject die steels to less erosion. Aluminum and magnesium alloys adaptable to the die-casting process are now available, and are being used for quantity production of light-weight parts. The possibility of simplifying design and reducing cost through the combination of several parts in one die casting, and at the same time obtaining smooth surfaces and close dimensional tolerances, has had an important effect on many phases of product design. All of these advantages, however, have been made available only through the metallurgical development of strong, stable, low-cost alloys for die-casting.

Among other important developments affecting engineering design, welding is one which is only beginning to find its place. Electrical resistance welding, flame welding and arc welding are each producing fundamental changes in design procedure, calling for new metals and alloys, new design methods and new forms of products. The importance of this development is well illustrated by the fact that the transition from riveted to welded design for boiler shells and

This "Streamline" kitchen sink is made possible by the use of metal
(Courtesy the International Nickel Company, Inc.)

pressure vessels is now complete. And in other products such as electric motors, presses and machine tools, domestic heating equipment, refrigerators and washing machines, chemical evaporators and fractionating towers, railroad cars and locomotives, welding has reduced costs and brought many design improvements during the past five years.

Much of this advance, however, has only followed the development of suitable welding rod materials meeting requirements of specific applications. For example, in welding corrosion-resisting steels, welding rods recently have been developed that produce welds as corrosion resistant as the welded parts. In welding high-strength alloy steels and copper alloys, welding rods, welding methods and equipment are now obtainable giving welds as strong as the base metal.

Many other design requirements possibly of equal importance have yielded to persistent metallurgical research producing, for example, several varieties of free-machining steels, deep-drawing steel sheets that are not subject to stretcher straining, low-cost machinable cast iron alloys giving greater wear resistance in automobile cylinder blocks and cylinder liners for diesel engines, single-quench carburizing steels for gears and pinions, high strength yet ductile brass and bronze alloys, leaded-bronze bearing alloys that can be used at higher temperatures and higher bearing pressures, new nickel alloys having unusual elastic and magnetic properties, brazing and soldering alloys giving joints as strong and tough as the joined metal, new thermostatic bimetals with greater sensitivity and higher permissible working temperatures, improved nickel-chromium alloys giving longer service in electrical heating elements, growth-resisting cast iron for carburizing boxes and furnace parts—and, engineers can mention many more that have directly influenced the performance and sales value of their products.

With this array of new metals and alloys it is no wonder that engineering design has shown such progress in the past five years. Yet, even greater opportunities await further reductions in the cost of many of these desirable engineering metals.

Carborundum Radio Programs

Announcement is made of the return of the now famed Carborundum programs to the air for the season of 1934-35. These programs are scheduled for Saturday nights 10:00 to 10:30 E.S.T. beginning October 20th, over a coast to coast network of Columbia Broadcasting System stations.

This is the ninth season for Carborundum on the air and once again will be featured the Carborundum band of fifty pieces under the direction of Edward D'Anna, and the telling of the fascinating Indian legends and interesting and instructive industrial stories on the manufacture and uses of the abrasive products of The Carborundum Company. Radio listeners identified with all types of industry will be much interested in these talks as they are planned and told with the least possible amount of usual radio advertising. Rather, they are planned to be at once informative and interesting.

Francis D. Bowman, Advertising Manager of The Carborundum Company will continue to write, produce and announce these programs.

Meeting International Acetylene Association

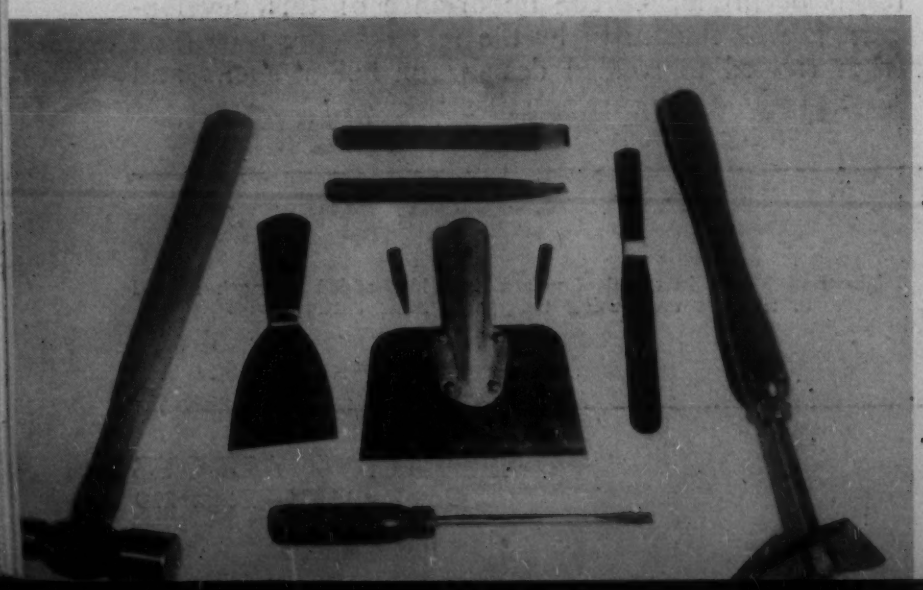
Preparations are fast assuming final form for the annual meeting of the International Acetylene Association, which will be held at the William Penn Hotel in Pittsburgh on November 14th, 15th and 16th.

Acceptances to address the convention have already been received from Former Governor John P. Fisher of Pennsylvania, Dr. George T. Baker, President of the Carnegie Institute of Technology, Dean E. A. Holbrook of the University of Pittsburgh, Prof. J. H. Zimmerman, Massachusetts Institute of Technology, Mr. A. R. Ellis, Vice-President of the Pittsburgh Testing Laboratories, Mr. E. W. Smith, Vice-President of Pennsylvania Railroad, Dean R. L. Sackett of Pennsylvania State College, and Mr. E. F. Blank, Jones & Laughlin Steel Company.

The technical sessions of the convention will stress such important subjects as Oxy-Acetylene Cutting as Applied to Steel Mill Applications; the Metallurgical Aspects of the Oxy-Acetylene Welding Process; Pipe Welding and Testing; The Application of Welding to the Transportation Industries; and Education and Safety in Welding.

The Association is meeting for the first time in the Pittsburgh area, and, based on the interest already expressed in the Association's convention, a record attendance is expected. The Association's Secretary is Mr. H. F. Reinhard, whose office is at 30 East 42nd Street, New York City.

E. W. Stewart, Engineer, Wm. D. Gibson Co., Chicago, Ill., will speak before the Chicago Chapter of the American Society for Metals at its regular monthly meeting on Oct. 11, 1934. The meeting and dinner will be held at the Medinah Club of Chicago, 505 N. Michigan Ave.



Due to the special properties of Beryllium Copper, it is possible to produce non-sparking tools

"For to Catch a Whale"

By John Howe Hall*

No. 6 in a Series of Case Histories in Metallurgical Research

THIS IS THE plain, unvarnished tale of a research that started with the object of finding a steel suitable for larger and heavier manganese steel castings than had ever been produced, and wound up with the first successful welding rod for manganese steel. It reminds one a little of some of the political cartoons by the inimitable Ding showing some national figure going gunning for ravening bears and returning triumphant holding by one leg a small and inoffensive snipe. The metaphor fails, however, when one remembers that though a welding rod is a relatively small piece of steel, the aggregate tonnage represented by welding rod sales is enormous. Why manufacturers of manganese steel castings should promote the invention and sale of welding rods for their product is another matter that may, on first thought, cause surprise. That comes later, when we have told a little more about the initial bear-hunt!

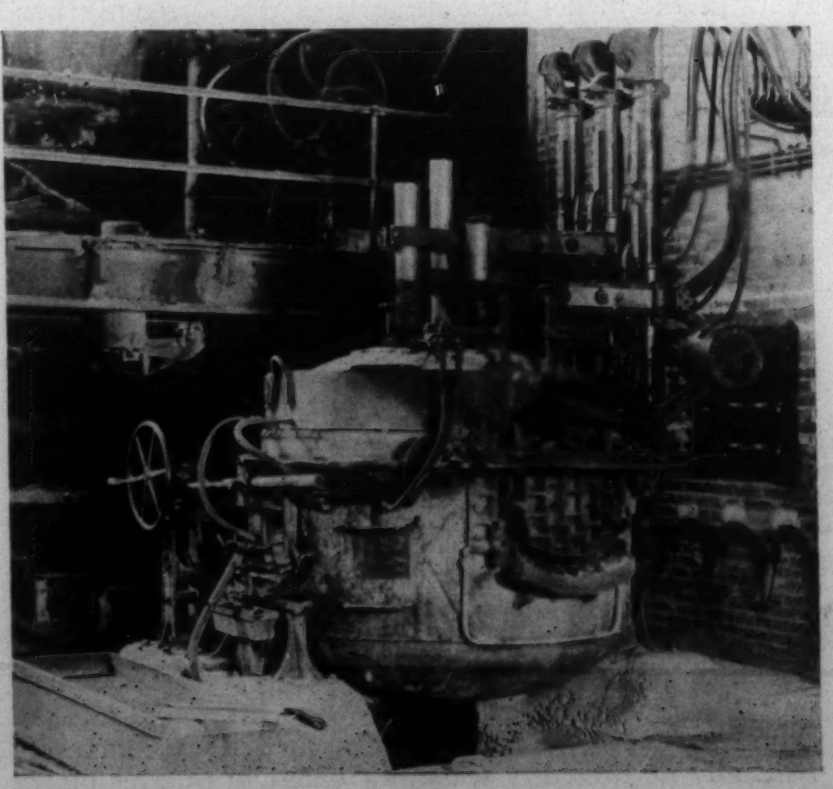
Manufacturers of Hadfield's manganese steel quite early learned by sad experience that there is a very positive upper limit to the thickness of castings or forgings that can be successfully produced. Heavier pieces were generally found to break, either in manufacture or in service, and in most cases the fresh fracture revealed the unsuspected presence of what the industry has come to term an "inner check." This is a type of defect that starts within the piece and works toward the outside and unfortunately quite often is not found until service stresses have caused it to spread and reach the surface. Its genesis is the result of the peculiar properties of manganese steel and the heat-treatment to which it has to be subjected.

Though the high percentage of manganese in this steel tends to throw it into the austenitic state, rapid cooling in water from a high temperature is required to completely prevent transformation and, perhaps more important, to hold in solution the large amount of carbide present in the metal in the cast state and due to its comparatively high carbon content. This is usually from 1 to 1.30%, its source is the carbon in commercial 80% ferro-manganese, and it causes the steel to be greatly on the hyper-eutectoid side.[1] To absorb this carbide and keep it in solution, the steel must be heated above the cementite solubility line of the carbon-iron diagram and quenched in water.

In carrying out this heat-treatment, two of the properties of manganese steel cause difficulty—its low heat conductivity and its high coefficient of thermal expansion. The first makes it inevitable that in quenching, the outside of a manganese steel object will far outstrip the inside in rate of cooling; the second causes the total contraction that the outside attempts to undergo to be greater than in the case of other steels. Metals that harden and become brittle on quenching commonly crack on the outside from such a condition as this. Manganese steel, however, becomes tough and ductile when quenched, so that the outside actually yields to the stresses imposed upon it, without rupturing. As Howe expressed it in discussing piping in ingots, there is a "virtual expansion" of the outer layers of the part. That is, their contraction being prevented by the hot, expanded inner portions, their fibers actually elongate as they cool, so that the other layers finally assume a greater length than they would have had, could they have contracted normally.

As cooling proceeds, naturally a point is soon reached where the inner portions are cooling faster than the outer, and those outer portions have been stretched until they fit the inside, not while it is cool and contracted, but while it is hot and expanded. The continued cooling and contraction of the inner parts of the piece, therefore, first relieves the tension in the outer fibers, then replaces it with great compressive stresses, accompanied, of course, by tension of equal magnitude in the inner fibers. The latter part under the stress, forming the inner-check, which as aforesaid has a disgusting way of not always appearing upon the surface of the piece until it has been in service for a considerable time.

In actual fact, the tendency to "inner checking" restricts the manufacturer of manganese steel to a maximum section of 4½" to 5". Heavier sections, especially in a piece of complicated shape, almost always lead to difficulty, and the extent to which the foundry-



One Ton Electric Furnace at Taylor-Wharton Iron & Steel Company

* Technical Assistant to President, Taylor-Wharton Iron and Steel Company.

[1] For complete data on this point, see Bain, Davenport & Waring. *A.I.M.E. Technical Publication* No. 467. "The Equilibrium Diagram of Iron-Manganese-Carbon Alloys."

man has to resort to lightening cores, changes of section at vital points, etc., etc., has to be experienced to be appreciated.

To the writer and his associates, of course, it had long been plain that the necessity for water quenching greatly aggravated this difficulty and that if only an air-toughened manganese steel could be devised, the maximum thickness of castings could be far greater, since in air cooling the difference in cooling rate between inner and outer portions would be far less than in quenching. Some 8 years ago, therefore, when a small Ajax laboratory furnace became available for experimentation, it was natural that this problem was among the first to be attacked. In coöperation with Mr. Jos. S. Comerford, then in charge of the laboratories of the Taylor-Wharton Iron & Steel Company, the writer began to cast about for a solution. As far back as 1908, we had made a small amount of standard manganese steel to which had been added 2 or 3% nickel. As other manufacturers have recently learned by similar experiments, the nickel appears to have little if any effect upon the properties of the manganese steel after heat-treatment, and at that time its use was abandoned. The writer, however, had personally had the job of breaking from their "gates" a number of test bars of the nickel-manganese steel, and had tucked away in the back of his mind the fact that in the cast condition the metal was far tougher and harder to break than ordinary Hadfield's manganese steel. It had, in other words, far more air-toughening properties. It seemed probable, therefore, that nickel might be a useful constituent in the contemplated steel. We had learned also of some work in Germany with similar steels, with very low carbon content, that pointed in the same direction. Further, as unabsorbed carbides are quite largely responsible for the lack of strength of Hadfield's manganese steel in the cast or the normalized state, a lowering of the carbon content also appeared desirable.

As things turned out, the actual experimentation required not over two or three months, most of which was devoted to determining the most suitable content of carbon, manganese and nickel and the amount of chromium that should be added to the steel as a "stiffener" in certain cases. The chromium was resorted to when it appeared that though normalized test bars of the nickel manganese steel would readily bend 180° and sometimes flat on themselves (a thing no manganese steel had ever done before) yet it lacked to a certain extent the strength of the standard Hadfield's steel. Patents were issued to the writer and Mr. Comerford and assigned to Taylor-Wharton, and preparations were made to launch the manufacture of "bigger and better" manganese steel castings. Tests had, of course, been made to establish the physical properties and wearing qualities of the new steel, which have been published in other places.

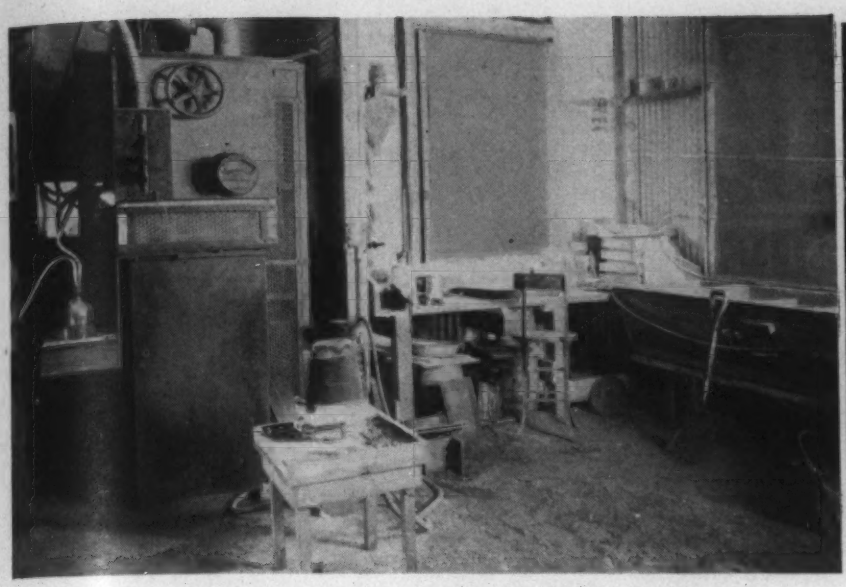
There are various parts of heavy crushing machinery that have for years been made of standard Hadfield's manganese steel, and as the size of the machines was increased from time to time, pressure had been brought upon us to produce the manganese steel parts in sections heavier than our experience told us was safe. By various expedients, such as coring out the most dangerous places, using a corrugated instead of a plain surface, and the like, compromises had been reached which in most cases satisfied the demands of service, and therefore, the customer. The investigation had been started to find a solution for jobs of this sort, and naturally no difficulty was anticipated in finding places in which the new metal could be tried out. To our surprise, however, we soon learned that our customers' designs and engineering practice had been standardized to conform with the limitations of regular manganese steel, and that there was no active demand for castings of heavier section than we could produce. We had, therefore, developed a steel to meet a supposedly existing demand, only to find that the demand, if it had ever existed, had temporarily ceased. A research, therefore, that had started in the preferred class, that is as a search for a steel whose market was ready and waiting for it, had to be abruptly switched to the far less desirable one of finding a market for a metal of given properties, for which no one appeared at the moment to have any particular use.

Fortunately, the statement at the beginning of this article is not strictly accurate, and a number of uses for nickel-manganese steel have been worked out, in addition to welding rod. In every case, too, they were uses to which standard manganese steel was unsuited in one way or another, so that while we had supposed all the time we were aiming only at the bear, there was actually other game in the field of fire, which was duly brought down and bagged. Were this an after dinner speech, the writer would introduce at this point the story of the old hunter whose boast of his beloved muzzle loader was that "If she didn't get what she went after, she 'most always got something else!"

For one thing, standard manganese steel can never be used in places where it is exposed to temperatures approximating dark red heat. Long exposure to such temperatures leads to the separation of the dissolved carbide in the austenite and to the eventual partial transformation of the austenite to troostite and sorbite, with almost complete loss of strength and toughness. The air-toughened nickel-manganese steel is not subject to this deterioration from exposure to low temperatures, and has proved itself admirably adapted to resisting wear combined with exposure to temperatures around 500° C.

Next in order in the line of cases where manganese steel had been found none too satisfactory was woven screens. Several companies specializing in screens had attempted unsuccessfully to develop the manufacture of screens from rolled manganese steel rod. The difficulty experienced was due to the slight decarburization of manganese steel in heat treatment. When the rods are crimped cold for weaving, numerous small cracks form all around the outside of each crimp, their depth and extent depending largely upon the degree of decarburization. In weaving, these inconspicuous cracks sometimes result in a broken rod, and in service they quite often cause premature failure of the screen. To crimp the bars hot is a remedy, but not an entirely satisfactory one, especially as the crimped bars must again be brought to a high temperature and quenched. The nickel manganese steel rods in the smaller sizes crimp cold without a sign of this development of "crimping cracks," and the larger sizes that require hot crimping are of course toughened on the same heat used for crimping, thus saving one heating. As a result, nickel-manganese steel screens have made a place for themselves, as attested by a steady and slowly growing demand.

"The poor we have always with us." The steel foundryman often recalls that phrase in looking over the results of the previous days' cast,—there are always at least a few cases where "something happens" to a casting and it must either be scrapped or repaired. The present writer has discussed in detail in several places the reasons why autogenous welding of manganese steel was so seldom successful up to a very few years ago.



Small Induction Furnace in Experimental Foundry

Battery of Induction Furnaces in New Foundry

Major repairs to a defective manganese steel casting were practically out of the question, if the part were to be subjected to severe stresses in service. The best welding rod we had then been able to find was 30% nickel steel, and that metal was subject to the insuperable difficulty that it would not rust or discolor, no, not though the chemist poured upon it all the drugs in the pharmacopoeia! This gave rise to differences of opinion with customers' engineers whose judgment of the advisability of welding some particular casting did not go along with ours. How those 30% nickel welds did shine out on a casting that had acquired a coat of good red rust!

If it be true that most marriages are the natural result of propinquity, it is equally certain that the development of nickel manganese steel as a welding rod was due to the same cause. Here was a defective casting, there was a piece of air toughening manganese steel rod of suitable size to make a weld, and both under the same roof! The first experiments with this steel to weld manganese steel castings were made in the shop where it was developed as a possible substitute for some of those same castings. The welds proved to be far tougher and stronger than any ever before made in manganese steel, and strong enough to allow not only the salvaging of defective castings, but the fabrication of finished parts in which manganese steel is welded to other metals. Their success has been confirmed by several years of successful service trials, by the doubtful compliment of imitation by others, and by the fact that the inventor of manganese steel has adopted nickel manganese steel welding rod as standard and commended it in print in his annual report to stockholders. We may get that bear yet, and meanwhile we've brought home a lot of other desirable game!

The Harold E. Trent Company, Philadelphia, Pa., announce the opening of their New York office at 143 Liberty Street. This office will be in charge of Mr. A. H. Gurtner.

The St. John X-Ray Service, Inc., Long Island City, N. Y., will conduct another training course on metal radiology during the week of October 8th.

The R-S Products Corporation has completed the purchase of all of the assets of patent rights, good will, etc., of Ryan, Scully & Company. This purchase was the result of an initial step taken over a year ago, when this corporation entered into a contract to take over the organization and the control of Ryan, Scully & Company. The facilities of the corporation have been increased through the purchase of the present office and plant property containing over 20,000 feet of floor space, and the installation of complete machine shop facilities for over 90% of the products made and the consolidation of all of our efforts under one plant location.

Detroit Electric Furnace Company, Detroit, Mich., makers of electric furnaces, has arranged with Battelle Memorial Institute, Columbus, Ohio, for an investigation of furnace construction and operation. The work at Battelle will be in charge of Harry B. Kinnear, metallurgist, and Chester R. Austin, refractories engineer. The program includes construction and operating features, and is expected to solve some metallurgical problems arising from the various applications of electric furnaces in ferrous and non-ferrous fields, especially in customers' problems.

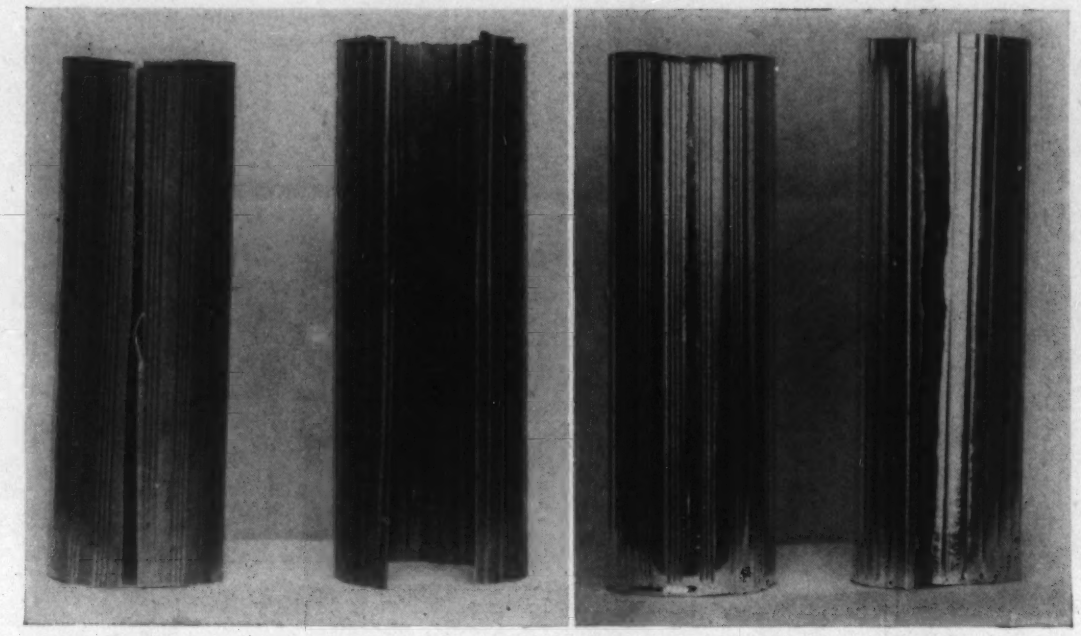
Plans for Photomicrographic Dark Rooms

As the result of many inquiries, Bausch & Lomb Optical Co., Rochester, New York, has prepared suggested plans for two photomicrographic dark rooms. One of these plans calls for the smallest usable space 6′ x 6′, for which any small room or closet, or even the corner of a room, may serve the purpose. The other plan is for an average size dark room, 9′ x 12′.

These layouts show the suggested arrangement of sink, safelight, shelves for chemicals, plates, films, paper, table, print-washer and drain-boards. Estimated costs for carpentry, painting, plumbing and electrical wiring are made. The customary materials needed for the dark room are listed and their total cost estimated.

The plans are printed on one side of a heavy cardboard poster, 9 1/2″ x 13″, on the other side of which the rules for using the dark room are printed, with a bold caption, "Knock Before Entering." Copies of these plans may be obtained on request.

Effective September 1st, 1934, **The Union Switch & Signal Company** of Pittsburgh is discontinuing its commercial drop forge business and transferring all dies and unfilled orders to The Champion Machine & Forging Company of Cleveland. Mr. Finley L. Walton, who has directed commercial drop forge sales for Union Switch and Signal Company, becomes affiliated with The Champion Machine & Forging Company in a similar capacity.



Split longitudinally: right—high internal stress; left—low internal stress.

Tested in Mercurous Nitrate: right—high internal stress; left—low internal stress.

The importance of internal stresses in manufacture is shown in the accompanying illustrations of flash light shells.

(Courtesy Bridgeport Brass Co.)

INTERNAL STRESSES

Part Five of a Correlated Abstract in Five Parts by Charles S. Barrett‡

RESULTS OF INTERNAL STRESS MEASUREMENT

A review of the more important facts regarding internal stresses, which have been discovered through the agency of the methods reviewed in this paper, will serve to illustrate the metallurgical application of these methods and to emphasize the practical importance of internal stresses. That guns, turbine wheels and other highly stressed metal objects can be made to withstand greater stresses by the introduction of suitable internal stresses has already been mentioned. A complete bibliography of such applications has not been attempted in this review, for most of them are not of general interest.

Season Cracking

The principal impetus to early work in the subject was given by the failure of articles of brass and other metals when subjected to stresses far below those for which they had been designed. Cracking was found to be most pronounced in cold worked brass and to occur sometimes even in the absence of applied stresses. This phenomenon, known as season cracking, is observed not only in brass and copper alloys, but also occasionally in alloys of iron, of nickel, and of aluminum. It may be started by vibration, mechanical injury, local or uneven temperature changes, oxidation, weathering, gas attack, and especially by the attack of ammonia and compounds of mercury on brass and the attack of acids and alkalies on steel.[102] Mechanical sectioning methods of stress analysis have proved that the presence of internal stresses are responsible for the trouble, and that it can be completely avoided by annealing to remove the stresses.† The exact annealing technique necessary for satisfactory removal of the cracking tendency without lowering the tensile strength of brass has been extensively studied by Masing, Moore, Beckinsale, Heyn, and others.[103]

The cracking tendency is known to increase in brass with the zinc content (occurring chiefly in brasses with a content of over 20% Zn) and to depend upon the distribution of internal stresses.[13] Owing to the unsatisfactory nature of the information obtained from the earlier mechanical sectioning methods of internal stress analysis, the exact relation between stress intensity or stress distribution and the tendency to crack has not been exactly determined in spite of some 20 years of research on the subject. For example, in two of the most recent papers on the subject we find, on the one hand, the theory that a certain type of distribution of stresses is determinative,[14] and on the other hand, the theory that the intensity of the stresses at the surface is of principal importance.[15] The role of preferred orientations is still less understood. Whatever these relations may be, it seems fairly certain that it is possible to form objects so as to avoid harmful stresses and to make stress relief annealing unnecessary.[15, 104]

‡ Metals Research Laboratory, Carnegie Institute of Technology.

† This statement is not meant to apply to stress cracking under externally applied loads.

Quenching Stresses

Among the most frequent sources of trouble in hardened steel are quenching cracks. The origin of quenching cracks was carefully studied by Scott[105] following less complete earlier researches[106] which linked quenching cracks with tensional stresses resulting from plastic deformation during the quenching process. Scott applied Heyn's mechanical sectioning method to quenched rods of tool steel, and showed that cracks occurred only at points where tensional stresses existed, and generally only when these occurred at the surface of the specimens. (Thus high compressional stresses at the surface of ball bearings, for example, are not a detriment and may even be an advantage in service.) Scott concluded that permanent tensional stress at the surface was produced only when plastic deformation had occurred during the period in which the specimen was undergoing expansion by virtue of the Ar″ transformation, and he developed formulas for estimating the magnitude of the internal stresses thus produced. From this study he was able to recommend practical expedients for the control of internal stress and the minimizing of quenching cracks.* The cause of grinding cracks has been shown by Scott to be the tempering of the surface under the grinding wheel, reducing the volume of the surface metal and throwing it into a state of tension.

A further development of the subject of quenching stresses along the lines sketched by Scott has recently been made at the Forschungsinstitut der Vereinigte Stahlwerke by Buchholtz and his associates. They have shown that two causes act separately to determine the final distribution of stress in a rapidly cooled steel: plastic deformation resulting from expansion during the transformation, and plastic deformation arising from contraction on cooling. The boring-out method of Sachs was used throughout their studies, after a comparison with several other methods had revealed its superiority. They maintain that in some instances the second factor, contraction on cooling, may produce even greater stresses than the first. While quenching stresses may be eliminated by annealing for about 6 to 10 hours at about 500° C., it is very necessary to

*The basis for his calculations had been laid by researches on internal strains in glass at the Geophysical Laboratory of the Carnegie Institute of Washington (L. H. Adams & E. D. Williamson, *Journal Franklin Institute*, Vol. 190, 1920, pages 597, 835.) The theoretical study of the problem has been continued by Scott (H. Scott, *Transactions of American Society for Metals*, Vol. 22, 1934, pages 68-94).

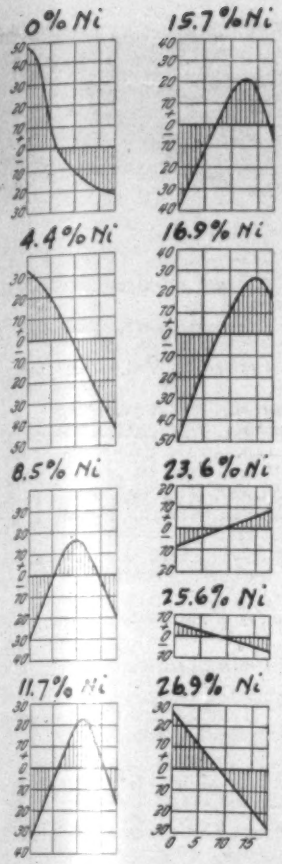
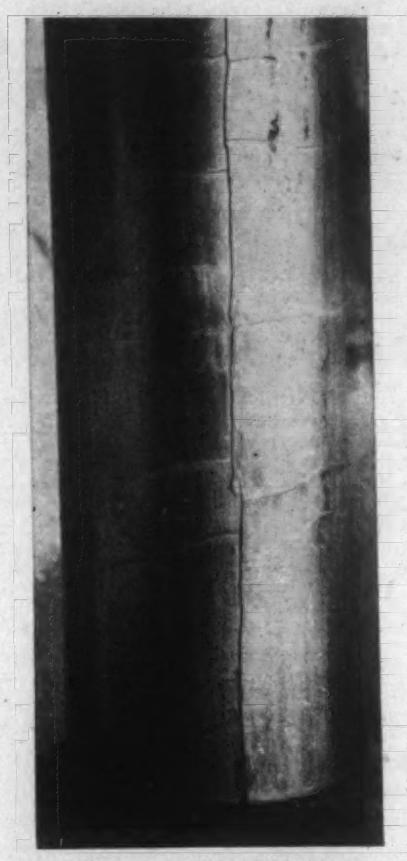


Fig. 24. Longitudinal stresses in quenched steels of different Ni content. (Bühler & Scheil)



Section of a brass rod which cracked upon immersion in a mercuric chloride solution (Sachs)

avoid rapid cooling from the annealing temperature if one is to prevent the reintroduction of stresses.[107]

When transformation and thermal contraction are both acting, the resultant stresses have a distribution which is determined by the temperature of the beginning of transformation, and by the relative amount of material that has been transformed.[108] This was shown, and the details of stress distribution worked out, by plotting a series of stress distribution curves for low carbon steels of different nickel content, in which the Ar_2 point was lowered, with increasing nickel content, down to room temperature with 25% Ni. The curves for the longitudinal stresses are reproduced in Fig. 24. The device of varying nickel content in this research was an indirect attack—through variation in the temperature of martensite transformation—on the problem of the effect of varying carbon content of plain carbon steel on the quenching stresses. It avoided the difficult and costly machining of tool steel specimens. Bühler and Scheil's curves, some of which are reproduced in Fig. 24, show clearly that under some circumstances the outer surface of a quenched rod may be quite free from stress (the back reflection X-ray method applied to the outer surface would in this case indicate no Heyn's stresses), yet the interior may contain stresses of the order of 40,000 lbs./in.^{2} In a cylindrical specimen the stresses at any given point, either at the surface or within, may be made either tensional or compressional by properly choosing the nickel content. It should be possible to do the same thing by varying the C content and quenching rate, for Scott[105] has shown tensile stresses to exist at the surface of tool steel which has been hardened throughout, and Bühler and his collaborators[107, 108] have found compressive surface stresses in structural steel. Furthermore, it is possible to have a quenched steel cylinder which is substantially stress-free throughout. This was the situation with 23-25% Ni in Bühler and Scheil's experiments. Very intense stresses are obtained in shallow hardening steels as compared with the stresses in deep hardening steels; longitudinal, tangential and radial stresses all increase with the velocity of quench, as was proved by cooling specimens in the furnace, in air, in oil, and in water.[107] *

Internal stresses in steel castings have also been extensively studied. Unfortunately the accurate mechanical methods, which are so effective in the study of quenching stresses, are not applicable to bodies of complex shape which are encountered universally in foundry practice. Consequently, the foundryman's knowledge of internal stresses has been gained by less precise measurements and by theoretical considerations.[109]

*The problem of quenching stresses in hollow cylinders has been studied by Buchholtz and Bühler, *Archiv für das Eisenhüttenwesen*, Vol. 7, 1933-1934, page 315; also by S. Fuchs, *Mitteilungen aus dem Forschungs-Institut der Vereinigte Stahlwerke Aktiengesellschaft*, Dortmund, Vol. 3, September 1933, page 199; and in this country by O. V. Greene, *Transactions American Society Steel Treating*, Vol. 18, 1930, page 369.

Internal Stresses and Fatigue

Internal stresses play a rather important role in determining the capacity of metals to withstand cyclic stressing. A great many fatigue studies[110] have indicated this, though the studies were usually made under conditions that did not fully isolate the effect of internal stress from the effect of other factors such as homogenization during the stress relieving anneal and the possible "cushioning effect" of retained austenite. Gillett and Mack[110] have shown, for example, that in carbon and low alloy steels quenched and drawn to spring temper, a definite increase in endurance limit may be obtained by a further draw of a few hours at about 500° C. The increase in endurance limit, amounting in some cases to as much as 35% and accompanied by a drop in Brinell hardness, could be ascribed to the relief of quenching stresses by the redrawing; accompanying changes in microstructure were judged to be factors of secondary importance. Similar conclusions were reached by French[111] largely on the basis of fatigue studies of steels in which the martensite transformation was made to occur at liquid air temperatures, where the generation of exceptionally high stresses was expected.

The most quantitative experiments on the subject are those recently performed by Bühler and Buchholtz,[112] who prepared carbon steels and low alloy Si-Mn steels with different stress distributions, but with practically the same yield point and ultimate strength in static loading. The stress distributions were determined by the Sachs' boring-out method. The following conclusions seem quite definitely proved by fatigue experiments on these samples. Compressive stresses in the outer layers of a cylindrical rod (obtained by quenching from 600° C.) can increase the endurance limit for bending stresses as much as 20%. On the other hand high tensional stresses in the outer layers (as in deep hardening tool steels and in cold drawn material) may decrease the endurance limit, though tensional stresses less than about 30,000 lbs./in.^{2} are harmless if the steel has sufficient toughness.

Bühler and Buchholtz have shown not only that internal stresses may considerably alter the endurance limit, but also that the fatigue process may greatly reduce the intensity of internal stresses by virtue of the plastic deformation that takes place with repeated stressing. An interesting test of this point was made on a 0.57% carbon steel rod quenched in ice water from 600° C. so as to produce compressive longitudinal and tangential stresses of +34 and +29 kg./mm.^{2}, respectively, in the outer fibers. After some 8 million reversals of ±30 kg./mm.^{2} stress, the outer fibers were found practically stress-free. Other less direct observations have also indicated a stress alteration during fatigue.*

Convincing as the experimental and theoretical data may be in regard to the relation between macroscopic stresses and fatigue, there remains practically unexplored the relation between microscopic stresses and fatigue. As was pointed out in the X-ray section of this abstract the pioneer X-ray studies of microscopic stresses during fatigue loading have been somewhat contradictory.

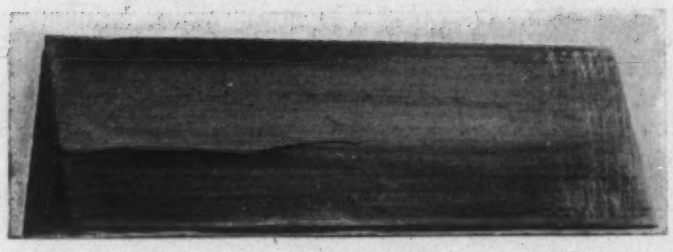
Other Mechanical Effects of Internal Stresses

Overstraining a metal in tension or compression raises the elastic limit for stresses in the same direction and lowers it for stresses in the opposite direction.[113] This is known as the Bauschinger effect. There is no doubt that this is a manifestation of internal stresses, for not only is it the type of effect to be expected from internal stresses, but furthermore, it is made to disappear by a stress relief anneal.

In internally stressed material the *apparent modulus of elasticity* is altered to values below normal for all applied loads such that the sum of the applied stress and the internal stress exceeds the elastic limit of the material.[15, 114] Related to this general subject is also the *dependence of stress-strain curves on the speed of deformation.* Stress-strain curves have lower values throughout when traced out slowly than when traced out rapidly, owing to the process of recovery going on during the progress of the test.[115]

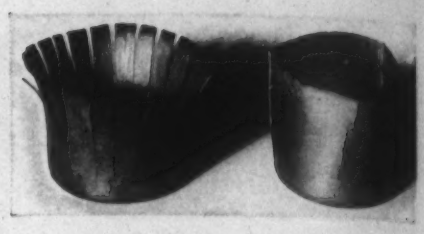
Elastic hysteresis or *internal friction* is another phenomenon closely related to the state of internal stress. Any solid material absorbs energy when put through a stress cycle involving shearing stresses in the body. It is generally considered to be

*See earlier section "The Effect of Fatigue on Line Width."



At left: Triangular brass tube containing internal stresses. Crack started by unequal temperature change

At right: Season cracks in brass. The cup on left cracked in mercuric nitrate, the one on the right in air. (Sachs)



the result of some type of slip within the body against frictional forces.[116] The phenomenon is studied by plotting the loop-forming stress-strain curve whose area gives the absorbed energy, or by direct measurement of the energy absorbed during a cycle. These studies have shown that elastic hysteresis depends on the previous deformation and the recovery of the sample, hence upon the state of internal stress.

The *elastic after-effect* ("elastische Nachwirkung") is the change of dimensions observed after applying and then releasing a load which exceeds the elastic limit. Non-uniform flow occurs during the loading, and upon the release of the load the residual elastic stresses gradually alter the dimensions. *Creep* of metals under load involves a number of the properties listed above, and may therefore be considered as a problem in the field of internal stresses. The mechanism of *recrystallization* is closely bound up with internal stresses; not only is the temperature at which it occurs influenced thereby (Polanyi and Schmid[115]) but also the locations within the deformed grain of the newly formed nuclei, their orientations, and their rate of growth.[117] There can be little doubt that the threshold temperatures for recrystallization and recovery are influenced by the state of internal stress.

Internal stresses, of course, affect properties other than the ones listed above; for example electrical conductivity, electrode potential, acid solubility and corrosion resistance, the propagation of mechanical vibrations,[118] the rate of transformation of phases and the rate of aging. Very little is known about the exact relation of internal stresses to these properties, chiefly because the process of setting up stresses also causes a fragmentation of grains and indeed, if carried far enough, a reorientation of grains, both being factors that have a powerful effect on these properties.

Summary

Perhaps the most valuable application of internal stress research has been to the problem of season cracking; it has shown ways of avoiding season cracking, but has not as yet definitely given us the exact relation between stress intensity or stress distribution and the tendency to crack. Quenching stresses in steel have also received much attention. Recent research by Buchholtz and his associates in Germany, following earlier studies in this country by Scott, is establishing the relationship of cooling velocity, annealing treatment, composition and critical temperatures, to the distribution and intensity of internal stresses. By the interaction of the processes of contraction during cooling and expansion during phase transformation a great variety of stress distributions are possible in quenched steel; the surface of a quenched rod may be stress-free in some instances, while stresses in the interior of the rod may amount to 40,000 lbs./in.^{2}, or under some circumstances the whole rod may be stress-free. Stresses produced in this way may increase the endurance limit if the surface is in compression, or decrease it if the surface is in tension.

The fields above mentioned have been explored more or less thoroughly. This, however, cannot be said for a great number of other fields, such as the relation of internal stresses to recrystallization and recovery, rate of transformation of phases, aging, propagation of mechanical vibrations, corrosion resistance, internal friction, and fatigue.

Bibliography

[102]Handbuch der Experimental Physik, Vol. 5. Akademische Verlagsgesellschaft M.B.H., Leipzig, 1930, pages 92, 475.

E. Heyn (Translation by M. A. Grossmann). Physical Metallography. Wiley & Sons, London, 1925, pages 228-244.

[103]Masing. *Zeitschrift für Metallkunde*, Vol. 16, 1924, page 257; First International Congress for Applied Mechanics, 1924, page 333.

E. Heyn & O. Bauer. *Internationale Zeitschrift für Metallographie*, Vol. 1, 1911, pages 16-50.

E. Heyn. *Journal Institute of Metals*, Vol. 12, 1914, page 1.

[104]Heyn. *Journal Institute of Metals*, Vol. 12, 1914, page 1. Some recent measurements on the stress distributions produced in drawn steel rod by different reductions of area are given by Bühler and Buchholtz in *Archiv für das Eisenhüttenwesen*, Vol. 7, 1933-1934, page 427.

[105]Howard Scott. *Scientific Papers, Bureau of Standards*, Vol. 20, 1925, pages 399-444.

[106]S. N. Brayshaw. *Journal Iron & Steel Institute*, Vol. 103, 1921, page 131.

G. Benedicks. *Journal Iron & Steel Institute*, Vol. 103, 1921, page 237.

A. Portevin. *Revue de Métallurgie*, Vol. 19, 1922, page 267.

Schwinning. *Journal Iron & Steel Institute*, Vol. 103, 1921, page 230.

T. McLean Jasper. *Engineering*, Vol. 118, 1924, page 343.

K. Honda. *Journal Iron & Steel Institute*, Vol. 103, 1921, page 251.

A. McCance. *Journal Iron & Steel Institute*, Vol. 103, 1921, page 267.

E. Heyn. Materialienkunde für den Maschinenbau. II, A-1912, page 331.

G. Masing. *Zeitschrift für technische Physik*, Vol. 3, 1922, page 167.

[107]H. Bühler, H. Buckholtz & E. H. Schulz. *Archiv für das Eisenhüttenwesen*, Vol. 5, 1931-1932, page 413.

Buckholtz and Bühler. *Archiv für das Eisenhüttenwesen*, Vol. 6, 1932-1933, page 247.

[108]Bühler & Scheil. *Archiv für das Eisenhüttenwesen*, Vol. 6, 1932-1933, page 283; Vol. 7, 1933-1934, page 359.

[109]See, for example, the treatment of "Heat Stresses" in Grossman's translation of E. Heyn's Physical Metallography. John Wiley & Sons, New York, 1925, pages 273-291.

[110]H. J. Gough. The Fatigue of Metals. Scott, Greenwood & Co., London, 1924.

H. W. Gillett & E. L. Mack. Molybdenum, Cerium and Related Alloy Steels. Chemical Catalog Co., Inc., New York, 1925.

H. F. Moore & J. B. Kommers. Fatigue of Metals. McGraw-Hill Book Co., New York, 1927.

R. Mailänder. See discussion of article by H. Bühler and H. Buchholtz, reference 107.

J. M. Lessells. *Transactions American Society for Steel Treating*, Vol. 11, 1927, pages 413-424.

A. Thum. *Zeitschrift Verein deutscher Ingenieure*, Vol. 75, 1931, pages 1328-1330.

J. H. Smith, C. A. Conner & F. H. Armstrong. *Journal Iron Steel Institute*, Vol. 120, 1929, pages 267-295.

H. J French. *Transactions American Society for Steel Treating*, Vol. 21, 1933, pages 899-946.

H. Döring. *Veröffentlichungen des Wöhler Instituts*, Braunschweig, Heft 5, 1930.

P. Behrens. *Veröffentlichungen des Wöhler Instituts*, Braunschweig, Heft 6, 1930.

E. Hottenrott. *Veröffentlichungen des Wöhler Instituts*, Braunschweig, Heft 10, 1932.

A. Armbruster. *Zeitschrift Bayerischen Revisionsverein*, Vol. 36, 1932, pages 199-205.

A. Thum & H. Oschatz. *Forschung aus dem Gebiete des Ingenieurwesens*, Vol. 3, 1932, pages 87-93.

[111]H. J. French. *Transactions American Society for Steel Treating*, Vol. 21, 1933, page 899.

[112]H. Buchholtz & H. Bühler. *Archiv für das Eisenhüttenwesen*, Vol. 6, 1933, pages 335-340; *Stahl und Eisen*, Vol. 53, 1933, pages 1330-1332. *Mitteilungen aus dem Forschungs-Institut der Vereinigte Stahlwerke Aktiengesellschaft*, Dortmund, Vol. 3, Sept. 1933, pages 235-248.

[113]Bauschinger. *Mitteilungen Mechanische Technische Laboratorium*, Technische Hochschule, München, Vol. 13, 1886.

J. E. Howard. *Transactions American Institute of Metals*, Vol. 7, 1913, page 101.

F. Sauerwald. Lehrbuch der Metallkunde, Verlag Julius Springer, Berlin, 1929.

G. Sachs. Handbuch der Experimentalphysik, Vol. 5, Akademische Verlagsgesellschaft M.B.H., Leipzig, 1930.

A. Nadai. Plasticity, McGraw-Hill Book Co., New York, 1931.

[114]M. F. Sayre. *Mechanical Engineering*, Vol. 51, 1929, pages 915-916.

[115]O. Haase & E. Schmid. *Zeitschrift für Physik*, Vol. 33, 1925, page 913.

E. Schmid. *Zeitschrift für Physik*, Vol. 32, 1925, page 918.

M. Polanyi & E. Schmid. *Zeitschrift für Physik*, Vol. 32, 1925, page 684.

[116]H. Fromm. Handbuch der Physicalische und Technische Mechanik. Barth, Leipzig, 1928.

Y. Kidani. *Journal, Faculty of Engineering*, Tokyo Imperial University, Feb. 1931.

R. H. Canfield. *Transactions American Society for Steel Treating*, Vol. 20, 1932, page 549.

[117]U. Dehlinger. *Annalen der Physik*, Series 5, Vol. 2, 1929, page 749.

J. A. M. van Liempt. *American Institute Mining & Metallurgical Engineers, Technical Publication No.* 15, 1927.

A. E. von Arkel. *Zeitschrift für Metallkunde*, Vol. 22, 1930, page 217.

H. C. H. Carpenter & C. F. Elam. *Proceedings Royal Society*, Vol. 100, 1922, page 352.

A. E. von Arkel & Ploos van Amstel. *Zeitschrift für Physik*, Vol. 67, 1930, page 43.

W. G. Burgess & P. C. Louwerse. *Zeitschrift für Physik*, Vol. 67, 1931, page 605.

Claussen-Nekludowa. *Zeitschrift für Physik*, Vol. 55, 1929, page 555.

[118]E. P. Polushkin. *Report Engineering Foundation* No. 6, 1923 page 42.

COPPER as an Alloying Element in Steel

By H. L. Miller*

THE FIRST question that presents itself to the mind in considering copper as an alloying element in steel is "Why use copper?"

Briefly, the points in favor of copper in steel are:

1. Copper increases the strength of the ferrite and produces a steel for normalizing treatment that is less affected by cooling rates than steels that use carbide formers for strengthening elements. Actual tests in mill practice on plates and sheets have shown that a 0.30 carbon, 0.70 manganese, 1.40 copper, 0.25 molybdenum steel when rolled into gages from ¼" down to 1/16" and normalized in a jobber furnace at a temperature around 1700° F. will show less than 5000 lbs./in.² variation in yield point, where a carbon manganese steel of the same carbon content: 0.28 C, 1.35 Mn showed nearly 20,000 lbs./in.² variation between 1/16" and ¼" gages. In this case the copper was combined with molybdenum to produce the strengthening of the ferrite.

2. Copper is low priced and plentiful and easily obtainable.

3. Copper can be controlled within very close limits as regards to the percentage range in the steel.

4. Due to its non-oxidation in open hearth practice the entire copper content in scrap is recovered in the metal when remelting. This factor is important when considering the manufacture of plates and sheets with the low percentage of yield in this department.

5. Copper alone or with other elements in combination seems to cause the rust formed in atmosphere to adhere tightly to the base metal and to remain as a protective film and reduce the rate of atmospheric corrosion. Exposed on a test fence in heavy industrial atmosphere for the four months and ten days from November 20, 1933, to March 30, 1934, sample sheets of regular open hearth steel were flaked off about 90% of their surface. Ordinary copper bearing was about 50% flaked off. The high copper molybdenum analysis mentioned before showed no flaking and the rust was very difficult to remove mechanically.

The total amount of rust formed was found to be about 11% less than on the regular analysis. Further weather tests are in process.

These five points in favor of copper are to be balanced against the following points against the use of copper:

1. Copper makes steel "hot short" causing trouble on blooming mills.

2. Copper causes the mill scale to adhere tightly to the metal when rolling plates and sheets, making it almost impossible to roll smooth surfaces as are produced in regular steel.

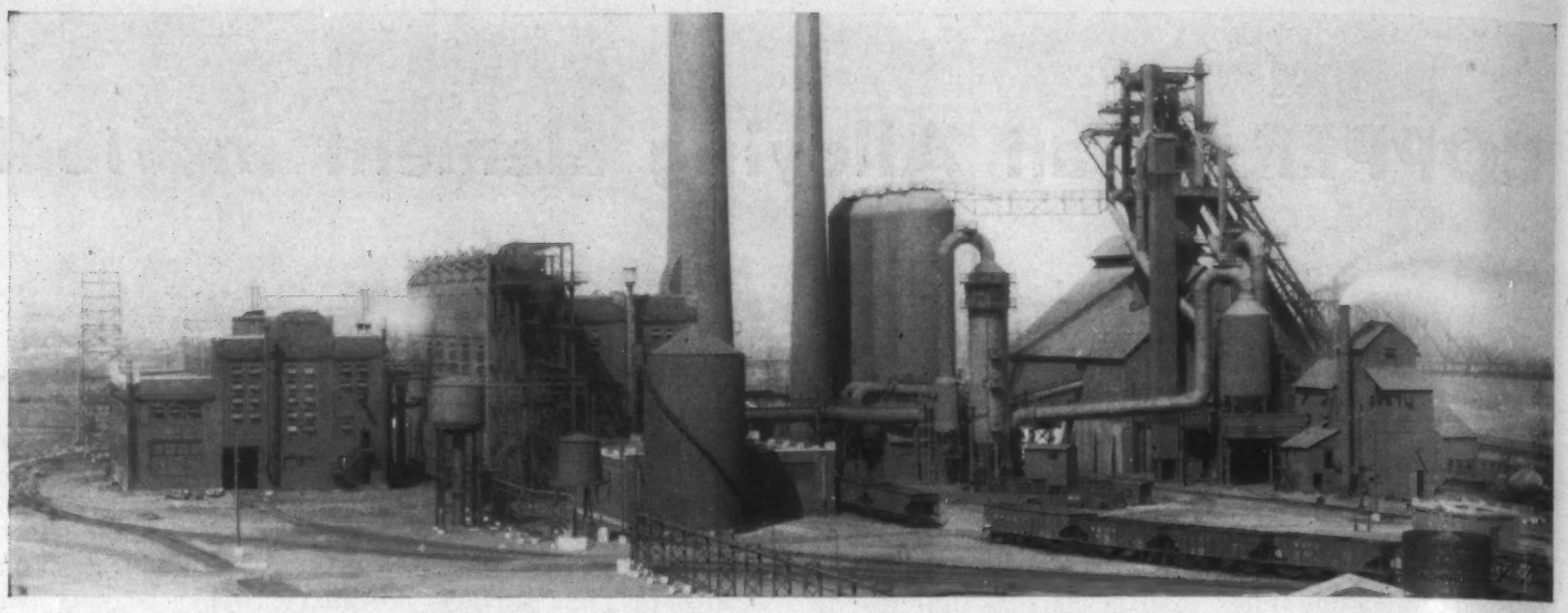
These two disadvantages in mill operations can be partially overcome by the addition of other elements to combine with the copper.

Nickel will reduce the red shortness but nickel copper steel shows even worse surface in sheets than the straight copper steels.

Molybdenum increases the solubility of copper in the ferrite and cuts down red shortness but still leaves a sticky mill scale to contend with on rolling sheets.

* Metallurgist, Republic Steel Corporation.

Charging Open Hearth at Massillon Plant, Republic Steel Corporation



Blast Furnace at Massillon Plant of the Republic Steel Corporation

Chromium in combination with copper and manganese was patented by Richardson. This steel is now coming into consideration as a high tensile sheet steel with improved resistance to atmospheric corrosion. The addition of molybdenum to this combination still further improves and tends to stabilize this analysis, particularly in the properties of normalized sheets.

A common steel sheet in 11 gage containing 0.25 carbon, 0.70 manganese when normalized from above the critical will show about 40,000 lbs./in.^{2} yield point and 65,000 lbs./in.^{2} tensile strength with about 25% elongation in 8". Addition of 1.35 copper and 0.25 molybdenum to the above carbon and manganese will develop about 75,000 lbs./in.^{2} yield point and 95,000 lbs./in.^{2} tensile with 15 to 20% elongation in 8 inches. We have approximately doubled the yield point of the steel by the addition of copper and molybdenum.

Increasing the strength without increasing the carbon gives us a material that is more applicable to welding in structures than the higher carbon steels which become brittle after welding.

The principal field for copper as an alloying element will be found in the development of lighter weight transportation equipment such as truck and trailer bodies, railroad freight containers and railroad freight cars.

Generally speaking the addition of copper will increase the strength of a material sufficient to allow from 20 to 40% reduction in weight or thickness of the structural members and the increased resistance to atmospheric corrosion will nearly balance up the reduction in thickness to give about the same length of service as the standard thicknesses of common steel.

With equal carbon content the manganese copper steels have lower physical properties than the molybdenum copper type. They also have less rust resistance but can be produced at lower cost. They will likely be found to be commercially applicable in freight cars while the molybdenum copper, chromium copper and chromium molybdenum copper steels will find their application in light weight passenger coaches, street cars, subway and elevated trains and in highway bus bodies.

Many of these analyses are still in the experimental stage but as mill practice experience accumulates, it will be found that copper really is entitled to a place among other elements as an alloy addition to steel.

Electrochemists Convene in New York

The Electrochemical Society, an international organization devoted to pure and applied electrochemistry and founded in 1902, is holding its meeting at the *Hotel Pennsylvania, New York City, September 27, 28 and 29*, 1934. It has been twelve years since the Society's last convention in New York.

Albert Sauveur Achievement Medal

The Trustees of the American Society for Metals at a recent meeting voted to establish an "Achievement Medal" for the recognition of metallurgical achievement which has stimulated work along similar lines and contributed to advances in metallurgical knowledge.

In recognition of Dr. Albert Sauveur's eminent contributions to the science of metallurgy, it was voted that the A.S.M. Achievement Medal be named in his honor, and it will be known henceforth as the Albert Sauveur Achievement Medal.

As a fitting tribute to Dr. Sauveur who is Gordon McKay Professor of Mining and Metallurgy at Harvard University, he will receive the first Achievement Medal at the annual banquet of the American Society for Metals at Hotel Pennsylvania in New York City on Thursday evening, October 4.

Battelle Staff Additions

H. A. H. Pray has been appointed an assistant physical chemist in Battelle Memorial Institute, Columbus, Ohio. In 1921 and 1922 he obtained B. A. and M. A. from Oberlin College and Ph. D. from University of Wisconsin in 1925. During 1926-1933 Dr. Pray was professor of chemistry in West Virginia University. He is the author of five papers on physico-chemical problems.

R. W. Dayton has been appointed an assistant metallurgist in Battelle Memorial Institute of industrial and scientific research, Columbus, Ohio. In 1931 he graduated as a chemical engineer from Rensselaer Polytechnic Institute, gaining his M. S. in 1932 and his Ph. D. in 1934.

R. S. Peoples, a graduate in metallurgical engineering from Ohio State University in 1933, has just joined the staff of Battelle Memorial Institute, Columbus, Ohio.

Carboloy Moves To Larger Factory

Carboloy Company, Inc., formerly located at 2481 East Grand Boulevard, Detroit, Michigan, have moved their General Offices, Detroit District Office, and Main Manufacturing Plant to new, larger quarters at 2985 East Jefferson Avenue, Detroit, where they will occupy two entire floors of a modern manufacturing and commercial building.

LETTERS TO EDITOR

Non-Aging Iron and Steel for Deep Drawing

Editor, METALS AND ALLOYS:

May I comment on the article "Non-Aging Iron and Steel for Deep Drawing" by Hayes and Griffis in your May issue?

The authors are to be commended for so clearly and precisely demonstrating the difference between aging and non-aging sheet. The liability of forming stretcher strains during the drawing of sheet has naturally focused attention on the stress-strain curve in the tension test, particularly in the region of the drop of the beam. Such test procedure, after deformation and aging, both at room temperature and in the blue heat region, has in the hands of the authors and their co-workers proved highly advantageous in comparing aging and non-aging sheet. Previously, as applied to thicker material, the most common procedure had been to make notched-bar impact tests, after deformation and aging at room temperature or heating to the blue heat region. This gave very striking evidence of the resulting embrittlement in aging steel, and the relative absence of embrittlement in non-aging steel, but, of course, did not apply to sheet so directly as do the tests described in the article.

However, the application of an effective method of test, in itself by no means new, assuredly does not constitute the invention of a unique material, as is implied in the article. As it is stated therein, that only recently has it become possible to publish the information as to the composition and processing of the non-aging sheet, apparently referring to the issuance of the French patent[1] for this material, this point will bear further discussion.

From the composition given in the article it is plain that the non-aging sheet is simply a killed iron or steel strongly deoxidized with aluminum and titanium. A U. S. patent[2] has already been granted for a similar non-aging iron and steel killed by a "high grade deoxidation" with aluminum or other strong deoxidizer, the steel having become fairly well known under the trade name Izett.[3] Even the Izett patent, were it to be passed upon by the courts, would probably not be adjudged as seriously affecting the commercial situation since its claims involve controlling the deoxidation by means of tests on worked and aged specimens taken during the progress of the heat. Once the proper amount of aluminum is determined for a given plant's melting practice on the basis of the properties of the final product, such control would be unnecessary. The patentee obviously realized that this is a late day for a patent to be granted on an aluminum deoxidized steel. The writer confesses to having tried to obtain a patent on an open-hearth iron killed with titanium about ten years ago but was unsuccessful even then.

It is very doubtful that any unusual recourses or furnace control tests are necessary to consistently make an Izett type of steel. It is merely sufficient to add the requisite amount of aluminum at the right time and place as judged by any competent melter and open hearth metallurgist. As the amount of aluminum required appears to be so moderate as to be well within the range customarily used in ordinary killed steel, the writer cannot see how such a steel can infringe on any patent.

That Izett steel has exactly similar non-aging characteristics to the non-aging sheet described in the article is attested by data on Izett given by Mehl,[4] formerly a co-worker of the authors. Mehl has shown that Izett does not increase in tensile strength in the blue-heat region. The authors, in the article being discussed, strongly emphasize that the failure of a steel to show an increase in strength in the blue heat region is closely related to non-aging characteristics and springs from the same causes. Indeed, two of the authors' co-workers have recently asserted[5] that tensile tests in the blue heat region probably provide the simplest means of distinguishing between aging and non-aging steel.

The article as well as the French patent state that it is essential for the attainment of non-aging properties to give the deoxidized sheet a special final heat treatment consisting of holding at 1180°F. for approximately 3 hours and cooling at a rate of about 10° to 15°F. per hour. That any such special treatment is necessary seems doubtful, but at any rate it is approximated during an ordinary box anneal.

The non-aging material is claimed to be more uniform from edge to center than the ordinary mild steel (rimming) sheet, but of course this would be true of all killed sheet. The attainment of such uniformity has been one of the main incentives to the numerous trials which have been and are being made with killed sheet. Killed steel has, of course, been frequently used in the past for sheet instead of higher phosphorus steel as a means of preventing sticking.

A. L. Feild some time ago made extensive tests with silicon killed sheet. These were finally abandoned because of the poor drawing quality and surface. With the lower silicon content in the aluminum and titanium killed non-aging steel described in the article the drawing qualities are no doubt better. The authors have omitted giving Olsen or Erichsen values which would have been of interest.

As for the surface this is probably largely a function of the proper degree of deoxidation. If one were willing always to add sufficient deoxidizer to give a fully killed deeply piping steel, much of the surface trouble might disappear. However, this would entail the expense either of hot topping or excessive top discard. In fact, the more extensive use of steel deoxidized with aluminum and silicon (frequently tried) has been limited by this very dilemma that too little aluminum leads to poor surface and too much gives excessive piping. The addition of titanium, a strong deoxidizer, appears to have a beneficial effect on surface, as might be expected, and this is especially pronounced in open-hearth iron low in carbon and manganese. Titanium may therefore, be an essential constituent of a non-aging open-hearth iron, whereas, in ordinary sheet steel there appears to be little doubt that a good non-aging material can be made without titanium. The need for the use of titanium (in the form of the more expensive low carbon variety of ferro-titanium to keep the carbon down) would appear to make non-aging ingot iron unduly costly, so that the production of non-aging steel sheet appears to offer more promise.

These aspects which are entirely slighted in the article must be considered from the standpoint of the commercial production of non-aging sheet. The contribution of the authors on the theoretical side deserves praise, but the subject of non-aging steel has long ago ceased to be merely an academic matter, and has become one on which practical progress has been made by many up-to-date steel makers.

Since no U. S. patent has yet been issued for the material described in the article, it seems unlikely that the use of the old standbys Al and Ti as deoxidizers which open-hearth steel melters and metallurgists have long been accustomed to use freely, will be restricted by patents.

J. H. NEAD,
Chief Metallurgist

Inland Steel Company,
Indiana Harbor, Ind.
August 3, 1934.

Editor, METALS AND ALLOYS:

Mr. Nead's comments of August 3 indicate that he has misunderstood or misinterpreted parts of our article on NON-AGING IRON AND STEEL FOR DEEP DRAWING, and for this reason we believe they warrant a detailed analysis. As a background from which they should be considered, the following statements should be made:

1. The purpose of the article was to present the requirements for obtaining iron and steel free from the phenomena of over-strain aging and blue brittleness: chemical composition and heat treatment.
2. In order that the reader might have at hand the methods of test for strain aging used by the authors and the effects of the phenomenon of aging, these were described.
3. Certain characteristics such as uniformity of physical properties, freedom from segregation, low rates of work hardening in temper rolling, and excellent drawing behavior of the non-aging material, which may, or may not, be related to the non-aging characteristics, were given.
4. Nothing whatever was said in the article about the patentability of any of the features of the development.

In the analysis of Mr. Nead's comments, we shall refer to specific statements:

---

[1] French Patent, No. 746,834, 1933.

[2] U. S. Patent, No. 1,729,378, 1929.

[3] G. Neuendorff. Izett Steel, What It Is and What It Is Used For, *Metals & Alloys*, Vol. 3, 1932, page 61.

[4] R. F. Mehl. The Aging of Iron and Steel. Lecture at Ontario Research Foundation, Toronto, Canada, October 31, 1930.

[5] R. L. Kenyon & R. S. Burns. Testing Sheets for Blue Brittleness and Stability Against Changes Due to Aging. Preprint 27, A.S.T.M., June, 1934.

1. *Page 229, paragraph 3*

"However, the application of an effective method of test, in itself by no means new, assuredly does not constitute the invention of a unique material, as is implied in the article." There is no implication in the article that the chemical composition, heat treatment, method of testing, or combination of same may be patentable.

2. *Page 229, paragraph 4*

"From the composition given in the article it is plain that the non-aging sheet is simply a killed iron or steel strongly deoxidized with aluminum and titanium." This statement is inaccurate. The fact that Mr. Nead fails to recognize the important effect of a proper thermal stabilizing treatment is the source of the error.

"The article as well as the French patent states that it is essential for the attainment of non-aging properties to give the deoxidized sheet a special final heat treatment consisting of holding at 1180°F. for approximately three hours and cooling at a rate of about 10 to 15° per hour. That any such special treatment is necessary *seems doubtful,* etc., etc." (italics ours). In both the article and the French patent this specific heat treatment is given only as an example. This statement further emphasizes Mr. Nead's failure to appreciate the importance of a proper thermal stabilizing treatment. A simple experiment such as testing an iron, of the composition given, in the normalized only condition, and again in the stabilized condition, using the methods of testing and the criteria for judging freedom from over-strain aging set forth in the publication of Kenyon and Burns which Mr. Nead has cited, will convince him of the necessity for this treatment.

3. *Page 229, paragraph 6*

"That Izett steel has exactly similar non-aging characteristics to the non-aging sheet described in the article is attested by data on Izett given by Mehl, formerly a coworker of the authors. Mehl has shown that Izett does not increase in tensile strength in the blue-heat region, etc., etc."

The experimental work recited by Mehl in his Toronto address was a survey by him of certain German work. The data presented by Mehl are not tensile data; they are impact toughness data obtained on samples which had been cold worked before heating to the testing temperature. Under these conditions a falling off in impact toughness in the blue brittle range indicated susceptibility to aging, while a decrease in tensile strength would have indicated freedom from aging.

Mehl in his Toronto address, said: "Thus though Izett is not free from blue brittleness, it appears definitely to be an improved material and will probably find its proper sphere of usefulness."

If Mr. Nead will conduct a test on Izett steel, preferably on low-carbon Izett (because such a carbon content makes possible a pronounced yield point) in the normalized only condition, and again after a proper thermal stabilization, using the testing method outlined by Kenyon and Burns, he will find that such a *strongly deoxidized* material may be made either free from, or distinctly subject to, over-strain aging.

4. *Page 229, paragraph 3*

".....The writer confesses to having tried to obtain a patent on an open-hearth iron killed with titanium about ten years ago but was unsuccessful even then." While the authors consider the discussion of patentability in connection with this article improper, it now seems necessary to state that the patent application mentioned by Mr. Nead contained nothing in regard to the prevention of over-strain aging.

5. *Page 229, right column, paragraph 2*

"The non-aging material is claimed to be more uniform from edge to center than the ordinary mild steel (rimming) sheet, but, of course, this would be true of all killed sheet." In the article the authors wrote: "It differs from *rimming* steels in that it is essentially free from segregation in composition and variation in grain size throughout the structure," clearly classing it with other killed steels in this respect, and contrasting it with rimming steels.

6. *Page 229, right column, paragraph 5*

"These aspects which are entirely slighted in the article must be considered from the standpoint of the commercial production of non-aging sheet, etc., etc." The authors admit having omitted reference to most of these aspects because, to a major extent, they are out of place in a technical article.

We agree with Mr. Nead that "the subject of non-aging steel has long ago ceased to be merely an academic matter," and we believe that our discovery of the essentials for obtaining the high degree of stability against over-strain aging necessary to prevent impairment of deep drawing qualities constitutes real "practical progress."

ANSON HAYES.
R. O. GRIFFIS.

American Rolling Mill Co.,
Middletown, Ohio,
September 4, 1934.

Lattice Recovery Under Stress

Editor, METALS & ALLOYS:

Very recently we have had confirmation, in a unique manner, of the relief of internal stress by the application of an additional stress. Fig. 1, shows an enlarged group of Gerlach doublets obtained from the third order X-ray reflection from an annealed 0.10% steel. The specimen is in the form of a small simple beam. Fig. 2 is an identical view of the same doublets after a calculated stress of 10,000 lbs./in.^{2} had been applied to the outer tensile fibers. The X-rays strike the surface of the specimen at a glancing angle of 15° and penetrate below the surface

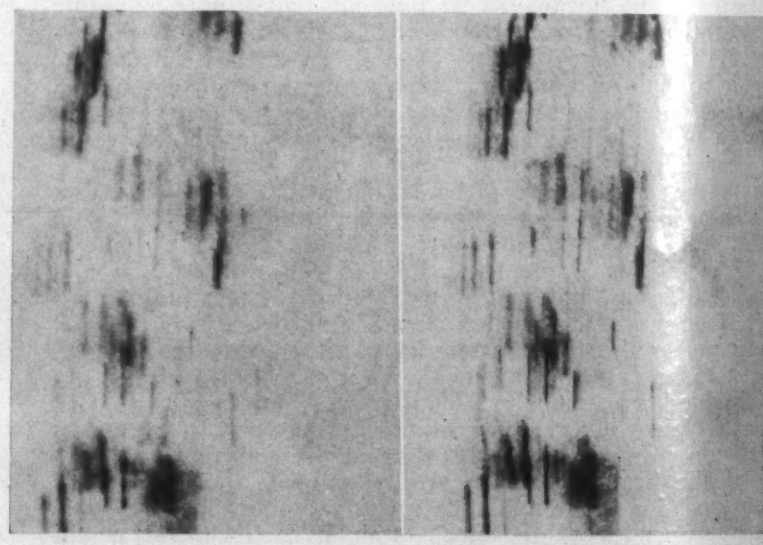


Fig 1. Annealed Structure

Fig. 2. Stressed 10,000 lbs./in.^{2}

less than one ten-thousandth of an inch. Reflections from identical crystals and their comparison offers a very positive proof of the increases in sharpness. Increasing the stress beyond 10,000 lbs./in.^{2}, causes a decrease in the resolution of the doublets.

DON M. MCCUTCHEON

Department of Chemical Engineering
University of Michigan
Sept. 6, 1934.

M. H. Mawhinney and **S. F. Keener,** formerly with the Electric Furnace Co., have organized the Salem Engineering Company, Salem, Ohio, for the design and manufacture of industrial furnaces.

Exhibit of Corrosion-Resistant Pipe Materials

Two years ago the National Bureau of Standards undertook to cooperate with pipe manufacturers and public utilities in the exposure of corrosion-resistant materials to corrosive soils. Recently two specimens of each of approximately 40 such materials were removed from each of fourteen locations.

Lack of funds will not permit the bureau to determine the corrosion losses of these specimens at this time. It has therefore cleaned the specimens as well as circumstances permit and after September 10 they will be available for examination in the Stucco Building at the National Bureau of Standards. The specimens may be examined any time prior to January 1, but, since the building is not heated, any extended inspection should be in September or October. Those wishing to examine the specimens should apply to K. H. Logan, 207 East Building, National Bureau of Standards, Washington, D. C.

ORE CONCENTRATION (1)

JOHN ATTWOOD, SECTION EDITOR

Lead and Zinc Mining and Milling in the United States. Current practices and costs. CHAS. F. JACKSON, JOHN B. KNAEBEL, & C. A. WRIGHT. *United States Bureau of Mines Information Circular* 6776, April 1934, 50 pages. Concentrating methods in 17 plants are summarized. Flotation is used either alone or with gravity concentration in most. Reagents, average grade of concentrates, average recoveries and costs at each mill are tabulated. AHE (1)

Operations of the Shenandoah-Dives Mining Company. T. R. HUNT & LEON M. BLANKS. *Mines Magazine*, Vol. 24, Feb. 1934, pages 7-12, 30. Most of the Au contents of the ore include pyrite, galena, chalcopyrite, sphalerite, and, very rarely, chalcocite. Milling operations are discussed by means of flow sheets. In flotation a lime circuit was used at a pH of 8.5. Flotation reagents are at present Midol pine oil, and amyl xanthate. Kz (1)

Crushing, Grinding & Plant Handling (1a)

A Discussion on Grinding and Classification Circuits. MAXWELL E. PLAYFORD. *Proceedings Australasian Institute of Mining & Metallurgy*, No. 91, Sept. 1933, pages 439-455. Thirteen various ball mill-classifier arrangements that can be used in wet grinding are discussed and flow sheets for each illustrated. AHE (1a)

Oxidation of Sulphide Minerals During the Process of Fine Grinding. V. A. MALINOVSKY. *Tzvetnuie Metallui*, No. 4, May 1933, pages 38-45. Author investigated the influence of oxidation during grinding for flotation on the losses in tailings due to the formation of oxidized films on the surfaces of the sulphide mineral particles. The results led to the following conclusions: (1) In the case of Cu—or pyritic Cu ores the oxidation has no appreciable effect on the results of flotation. (2) Soluble salts formed by oxidation of Cu-Zn ores, and Pb-, Pb-Zn and Cu-Zn ores containing pyrite and chalcopyrite are very harmful. (3) Oxidation of pyrite improves its flotation ability. BND (1a)

Flotation (1c)

Milling Methods at the Lead-Zinc Concentrator of the International Smelting Co., Tooele, Utah. W. J. MCKENNA. *United States Bureau of Mines Information Circular* No. 6758, Dec. 1933, 13 pages; *Mining Congress Journal*, Vol. 20, Feb. 1934, pages 24-26, 50. About 1150 tons of Pb-Zn ore are treated daily by flotation. A typical ore assays Pb 8.62%, Cu 0.42%, Zn 11.23%, Fe 9.75%, Au 0.137 oz. and Ag 7.10 oz./ton. The Pb concentrate assays Pb 64.02%, Cu 2.00%, Zn 7.67%, Fe 3.83%, insoluble 3.33%, Au 0.539 oz. and Ag 44.65 oz. and accounts for 93.62% of the Pb, 49.71% of the Au and 79.26% of the Ag. The Zn concentrate assays Pb 1.19%, Cu 0.65%, Zn 58.44%, Fe 3.28%, insoluble 2.50%, Au 0.116 oz. and Ag 3.67 oz. and accounts for 85.44% of the Zn, 13.86% of the Au and 8.49% of the Ag. The Fe concentrate assays Pb 0.80%, Cu 0.18%, Zn 2.71%, Fe 41.50%, insoluble 5.37%, Au 0.188 oz. and Ag 2.85 oz. and accounts for 67.00% of the Fe, 21.46% of the Au and 6.31% of the Ag. The tailing assays Pb 0.41%, Cu 0.05%, Zn 0.44%, Fe 3.98%, Au 0.037 oz. and Ag 0.76 oz. The flow sheet is described in detail. The consumption of flotation reagents in Feb. 1931 was soda ash 1.85, Na aerofloat 0.065, NaCN 0.217, $ZnSO_4$ 0.738, $CuSO_4$ 1.379, Aerofloat No. 15 0.100, K ethyl xanthate 0.314 and K amyl xanthate 0.115 lb./ton of ore. BHS + AHE (1c)

Flotation of Metallic Gold; Relation of Particle Size to Floatability. E. S. LEAVER & J. A. WOOLF. *United States Bureau of Mines, Report of Investigations*, No. 3226, Mar. 1934, pages 9-15. Clean metallic Au,—60 mesh in size, can be floated successfully from a siliceous gangue with or without pyrite with the usual flotation reagents used for sulfide ores. Au does not float as readily or as rapidly as most of the mineral sulfides. The Sub-A-type flotation machine is more effective in floating coarse Au than the straight mechanical type. Reagent No. 208 is the most effective promoter tried in this work. Used in a Sub-A machine, 96.2% of all —40 mesh Au and 99% of all —60 mesh Au was recovered. $CuSO_4$ does not increase the recovery but does aid by increasing the rate of flotation of Au under 60 mesh in size. Au coarser than 40 mesh is not recovered in the usual flotation concentrate. AHE (1c)

Electrokinetic Potentials and Mineral Flotation. HENRY B. BULL, BENNETT S. ELLEFSON & NELSON W. TAYLOR. *Journal of Physical Chemistry*, Vol. 38, Mar. 1934, pages 401-406. Cataphoretic studies have been made on a number of pure minerals suspended in pure water. The study has been extended in the case of galena, sphalerite and quartz to include several electrolytes at various concentrations. Comparison of the data on surface charge of galena with the experimenter's earlier work on flotation under similar conditions of added electrolytes shows that peptization rather than flocculation is a necessary requisite for good flotation, to be followed by the addition of suitable collecting agents. EF (1c)

Flotation Popular; Crushing Is Finer. ALLAN J. CLARK. *Mining & Metallurgy*, Vol. 14, Jan. 1933, pages 15-16. Discusses the development of flotation and crushing of Au ores during the past year. VSP (1c)

Effect of Particle Size on Flotation of Sphalerite. R. L. KIDD & W. A. WALL. *Mining & Metallurgy*, Vol. 14, Oct. 1933, pages 421-422. Describes flotation tests conducted with sphalerite especially free from Cu. Sizes coarser than 200 mesh were separated by screening, sized mineral was deslimed on Wilfley table. Results of tests showed: (1) Finer sizes of sphalerite require less cresylic acid to give best froth character; (2) Recoveries increase with increase in amount of froth used, but more gangue is carried over; (3) Finer size sphalerite requires more Cu SO_4 and potassium ethyl xanthate for best recoveries. Reverse is true in larger sizes; (4) Recovery of fine sizes can be improved by increasing length of collecting period as by using more flotation cells. VSP (1c)

Floating Molybdenite in Morocco. *Engineering & Mining Journal*, Vol. 135, Feb. 1934, page 586. In Morocco in the district of Azegour South Marrakesch, a molybdenite deposit is being worked. Twenty-five tons per month of Mo concentrates are produced, containing 85% MoS_2. Flotation is selective due to the chalcopyrite content of the ore. A flowsheet, operating results, and power requirements are tabulated. WHB (1c)

Amalgamation, Cyanidation & Leaching (1e)

Recovery of Refractory Gold in Milling Ores. E. S. LEAVER & J. A. WOOLF. *United States Bureau of Mines, Report of Investigations*, No. 3226, Mar. 1934, pages 3-8. Cyanidation largely replaced amalgamation; now it is being replaced by flotation. Amalgamation is recommended as a primary process to recover coarse Au before cyanidation or flotation. Au encased in pyrite, silica, or other minerals can be recovered only after finer grinding. Talcose ores require a depressant, such as starch, to insure a good grade of flotation concentrate. Au in base metal ores and ores that form cyanicides favor flotation prior to cyanidation. AHE (1e)

Form and Occurrence of Gold in Pyrite from a Metallurgical Standpoint. R. E. HEAD. *United States Bureau of Mines, Report of Investigations*, 3226, Mar. 1934, pages 27-31. All Au found so far in cyanide residues occurred as minute flakes on the crystallographic planes of pyrite. The flakes are of very small size. The pyrite in which such Au occurs is crystalline. Fine grinding to liberate Au is ineffective as continued grinding contaminates the Au surface with very fine slime. AHE (1e)

Re-Treating Tailings for Gold at Mercur. *Engineering & Mining Journal*, Vol. 135, Feb. 1934, pages 54-55. A flowsheet is shown of the Manning countercurrent decantation cyanide plant of Manning Gold Mines Co. The capacity of the plant is 600 tons per day and Au values are $2-$3 per ton. WHB (1e)

ORE REDUCTION (2)

A. H. EMERY, SECTION EDITOR

Non-Ferrous (2a)

1

Electric Heat and Fusion Electrolysis (Elektrowärme und Schmelzflusselektrolyse) H. KIRCHRATH. *Elektrowärme*, Vol. 3, Dec. 1933, pages 368-371. Electrolytic production of Na, Al and Mg from their molten salts is discussed and the required heat calculated. Physical and chemical data are given, some processes and equipments are described, and statistics on world production and required electrical energy are given. 8 references. Ha (2a)

Cadmium, Thallium, Indium, and Gallium as By-Products of the Lithopone Industry. W. N. HIRSCHELL. *Journal Society Chemical Industry*, Vol. 52, Oct. 6, 1933, pages 797-798. Directions are given for the recovery of Cd, Ti, In, and Ga in the manufacture of lithopone. VVK (2a)

2

Chlorine Smelting with Chloride Electrolysis. EDGAR A. ASHCROFT. *Bulletin Institution of Mining & Metallurgy*, No. 354, Mar. 1934, pages 57-68. Discussion. See *Metals & Alloys*, Vol. 5, May 1934, page MA 172. AHE (2a)

Development of Monolithic Tamped Periclase Converter Linings at United Verde Copper Company Smelter. F. H. PARSONS. *Transactions American Institute Mining & Metallurgical Engineers*, Vol. 106, 1933, pages 153-164. Includes discussion. Fused MgO, periclase, is mixed with molasses or a small amount of clay and a small amount of water and rammed in. H_2SO_4 is added to neutralize the CaO in the periclase. The plasticity is dependent on the pH of the mix. The lining is cheaper than brick. JLG (2a)

3

Ferrous (2b)

Blast-Furnace Plants in the Soviet Union. *Iron & Coal Trades Review*, Vol. 128, May 11, 1934, page 767. Construction and operating data of some 1000-1200 ton units, storage, charging, Fe- and slag-handling systems are described. Ha (2b)

Crux of the Fuel Economy of Blast Furnace Operation. H. A. SPALDING. *Iron Age*, Vol. 132, Nov. 30, 1933, pages 20-21. Speculates that the failure of some of the larger furnaces to attain the fuel economy of smaller ones, is due more to getting the right amount of O "properly" to the fuel than any other factor. VSP (2b)

4

Carbon Separation in the Reduction of Iron Ores with Carbon Monoxide (Die Kohlenstoffabscheidung bei der Reduktion von Eisenerzen mit Kohlenoxyd). E. WOECKEL & W. BAUKLOH. *Stahl und Eisen*, Vol. 53, Feb. 9, 1933, pages 147-148. Recent experiments confirmed the results of H. H. Meyer (*Mitteilungen aus dem Kaiser Wilhelm Institut für Eisenforschung*, Düsseldorf, Vol. 10, 1928, pages 107-116) for the relations between temperature, degree of reduction and separation of C; the disintegration of a piece of ore is explained by diffusion of CO into the ore and attack of the latter from the inside. An ore of fine crystalline structure therefore, is disintegrated into a finer powder than a coarse crystalline ore. Ha (2b)

5

Value of Sponge Iron as Raw Material for Steel. HANS DIERGARTEN. *Metal Progress*, Vol. 25, June 1934, pages 49-50. ROHLAND, *Stahl und Eisen*, 1929, page 1477. Steel made with sponge Fe exhibits a more rapid solution of pearlite and broader temperature range or heat treatment than other steels. Improvements were thought to be due to "virginity" of the material. Plant scale research (Edwin, *Stahl und Eisen*, 1932, page 457) shows that use of sponge Fe in steel making is not as economical as use of pig Fe produced in modern blast furnaces, but improvements in properties of resulting steel may offset higher cost for certain applications. Combined S and P content is less than 0.025% and at least 90% reduction is effected. WLC (2b)

Wrought Iron Direct from Sponge Iron. *Iron & Steel of Canada*, Vol. 17, Jan.-Feb., 1934, pages 3-5. The production of high-grade sponge Fe and a material analogous to wrought Fe from concentrate prepared from Moose Mountain (Ontario) ore is described. OWE (2b)

6

Preparation of Carbon-free Alloys from Carbonized Ferrochromium (Darstellung Kohlefreier Chromlegierungen aus kohlehaltigen Ferrochrom). H. GRUBER. *Heraeus Vacuumschmelze*, 10th Anniversary Volume, 1933, pages 128-138. The C content of ferrochromium containing Cr 70-75 and C 6-4% can be reduced to not less than 0.51% by treatment with chromite-fluorspar mixtures or with hammer scale in the high-frequency induction furnace, but a considerable loss of Cr in the slag occurs. Treatment of the molten alloy with Cr_2O_3 in an atm. of H_2 at over 2000° effectively removed the C without appreciable loss of Cr; 10 kg. of alloy can be decarbonized in 6.5 hrs., with only 8 cu. m. of H_2. Water gas is less efficient than H_2 and chromite than pure Cr_2O_3. Ni-Cr alloys and carburized Cr can be similarly decarburized. Ni-Cr alloys with not more than 70% Cr can be made by reducing Cr_2O_3 with C over molten Ni and then treating the alloy with more Cr_2O_3 in H_2. The method has been used for preparing alloys of Fe and Ni with V and Ti. (2b)

7

The Binary System, MnO-SiO_2. J. WHITE, D. D. HOWAT & R. HAY. *Journal Royal Technical College*, Vol. 3, Jan. 1934, pages 231-240. The diagram for the system MnO-SiO_2 is developed from thermal data; phase changes were confirmed in many cases by observations with a high temperature microscope. A differential method was employed to obtain the thermal curves. No crucibles were used. The purities of the various metals were checked by chemical and spectrographic methods; the solid phases were confirmed by their optical properties. In the diagram obtained, the eutectic is shown at 37.5% SiO_2, melting at 1208°C. The melting point of MnO was found to be very much higher than previously obtained. JWD (2b)

8

Mud Guns and Tap Hole Hammers for Blast Furnaces (Stichlochstopfmaschinen und-hämmer für Hochöfen) H. KALPERS. *Technische Blätter der deutschen Bergwerkszeitung*, Vol. 24, Mar. 18, 1934, pages 172-173. Describes new installations of blast furnace mud guns, and a new compressed air hammer for opening blast furnace tap hole. GN (2b)

Tuyere Preserves Nose Profile. *Steel*, Vol. 94, Mar. 12, 1934, page 31. Describes the Beaton-Ledbetter refractory-nose tuyere. MS (2b)

9

Production and Properties of Sponge Iron (Herstellung und Eigenschaften des Eisenschwamms) *Die Metallbörse*, Vol. 23, Jan. 21, 1933, pages 82-83; Jan. 28, 1933, page 114; Feb. 11, 1933, page 179. Direct processes will become a competitor of blast furnaces. Reduction by gases, preferably CO, led to 2 commercially important processes: (1) Edwin (Norsk-Staal) and (2) Wiberg. The latter operates between 900° and 1050°C. Since equilibrium is at 20% CO_2, regeneration by C is performed in thin tubes including a 4000 volt arc. The gases are preheated to 1800°C. and led into a reduction chamber filled with coke. S is removed by passage through a lime chamber. The regenerated gases are free from S and P which contaminate the pig Fe in the blast furnace. The Fe sponge (sp. gr. = 2) is briquetted to Fe of 92% purity (sp. gr. = 6). The thermal efficiency is 93%. Experiments of Kamura on reduction of various Fe ores by H_2 are discussed and data on physical and chemical composition are presented. EF (2b)

10

Petrographic Methods in Slag Examination. R. GRAHAM & R. HAY. *Journal Royal Technical College*, Vol. 3, Jan. 1934, pages 241-243. The determination of the optical properties such as refractive index, pleochroism, extinction angle, etc. was found useful in the elucidation of the constitution of the MnO-SiO_2, FeO-MnO and FeO-MnO-SiO_2 systems. JWD (2b)

MELTING, REFINING & CASTING (3)

Non-Ferrous (3a)

G. L. CRAIG, SECTION EDITOR

An Electrolytic Gold Refining Plant in the Netherlands (Eine elektrolytische Goldraffinationsanlage in den Niederlanden). GOTTHARD E. LENK. *Metall und Erz*, Vol. 31, Feb. 1934, pages 77-81. The construction of the plant, equipment, and the refining process are described, and production costs are given. CEM (3a)

Recovery of Precious and Secondary Metals from Electrolytic Copper Refining. M. A. MOSHER. *Transactions American Institute Mining & Metallurgical Engineers, Copper Metallurgy*, Vol. 106, 1933, pages 427-440. The operations at the Ag refinery of the Raritan Copper Works at Perth Amboy, N. J., are described. Ag, Au, Se, Te, and metals of the Pt group are recovered. The slime-leaching tanks can handle 120 dry tons of raw concentrate per mo. and turn out from 60 to 90 dry tons of treated slime per mo. The electrolytic parting plant can handle 2,250,000 oz. of Ag per mo. The Au-refining plant can treat 35,000 oz. of Au per mo. Pt and Pd refining facilities are adequate for the production of 200 oz. per mo. of the 2 metals. The Se plant can handle 3000 lb. of Se powder per mo. and the Te plant 1500 lb.of Te per mo. JLG (3a)

Electrolytic Copper Refining at Mount Lyell, Tasmania. R. M. MURRAY. *Transactions American Institute Mining & Metallurgical Engineers, Copper Metallurgy*, Vol. 106, 1933, pages 408-416. Describes plant and operations. JLG (3a)

Waste-heat Boiler Practice at the Garfield Smelter. R. A. MARRIOTT. *Transactions American Institute Mining & Metallurgical Engineers, Copper Metallurgy*, Vol. 106, 1933, pages 257-261. Describes equipment and operation. JLG (3a)

Waste-heat Boiler Practice at the Magma Copper Company Smelter. J. H. ROSE. *Transactions American Institute Mining & Metallurgical Engineers, Copper Metallurgy*, Vol. 106, 1933, pages 255-256. Describes equipment and operation. JLG (3a)

Problems in Casting Brass Bars (Probleme zum Giessen von Messingbarren). WERNER FRÖLICH. *Zeitschrift für die gesamte Giessereipraxis*, Vol. 55, Apr. 15, 1934, pages 162-164. Discusses all the points of essential importance for obtaining sound, pore-free brass bar castings. Applications of water-cooled molds, casting methods, proper dimensioning of gates for regulating casting speed are discussed. As regards casting temperature opinions are divided whether low (950°C.) or high (1100°C.) temperatures should be applied. Author suggests best casting method at 1000° C. and filling-up at 1050°C. Various types of fluxes used for cleaning and degasifying melt and mold facing materials are discussed. Proper cleaning of mold subsequent to casting is highly important. GN (3a)

Molding Aluminum Bronze and Method of Controlling Quality (Moulage du Bronze d'Aluminium et Methode de Controle de la Qualite). CH. MEIGH. *Bulletin de l'Association Technique de Fonderie*, Vol. 8, May 1934, pages 180-186; *Revue de Fonderie Moderne*, Vol. 28, Apr. 10, 1934, pages 102-105. The quality of the casting depends upon obtaining appropriate cooling rates through the use of chill molds, hot dies, mixed molds, or sand molds. Micrographic study of the distribution of the constituents and the size of the grains gives information on quality. Ha & WHS (3a)

Casting a Pressure Vessel of Special Bronze (Der Guss einer Druckkammer aus Sonderbronze). FRIEDRICH WILHELM. *Zeitschrift für die gesamte Giessereipraxis*, Vol. 55, Apr. 1, 1934, pages 141-142. In describing manufacture of a pressure vessel, author discusses points to be observed in (1) molding, (2) alloying and (3) casting. As regards molding the following points are of particular importance, (1) piece to be molded must be so arranged in mold that faces to be machined are located in bottom part of mold, (2) sharp contours must be avoided to avoid metal from forming whirls in mold, (3) proper dimensioning of wall thickness. GN (3a)

Pouring Temperatures of Bronzes. EDMUND R. THEWS. *Foundry*, Vol. 62, Mar. 1934, pages 24-25, 52. Best bronze castings are obtained where casting temps. are as low as practical considerations permit. Chief disadvantages of high casting temps. are: porosity due to absorbed gas and shrinkage; coarse structure; pronounced liquidation phenomena. The shorter the freezing range of an alloy the more uniform and dense the casting. Freezing range of bronze castings may be reduced by using suitable alloying compositions, production of chill castings by using chill plates, etc., and casting at low temps. Sn sweat consists chiefly of delta eutectoid forming alloy and is most common with large castings rich in P and poured at high temps. Includes tables showing freezing range with Sn varying, analysis of Sn sweat in bronze castings and total shrinkage of some Cu alloys. VSP (3a)

Speculum Metal Castings. C. M. SAEGER, JR. *Metal Progress*, Vol. 25, June 1934, pages 53-54. Optimum composition for production of fine-grained castings free from excessive strains and of desired color is Cu 66.6% and 33.4% Sn. Procedure recommended is melt virgin Cu under cover of charcoal, add Sn to molten Cu, deoxidize with 0.5% Zn and pour at about 1750° F. Green sand molds of 00 Albany molding sand faced with rubber cement and Ceylon graphite are required to give surface desired. After complete solidification in molds castings are transferred, still hot, to a furnace and cooled to room temperature over a period of 18 hrs. WLC (3a)

Castability of Ternary Alloys (Contribution a l'Etude de la Coulabilite des Alliages Ternaires). A. PORTEVIN & P. BASTIEN. *La Fonderie Belge*, Vol. 3, Aug. 1933, page 113. See *Metals & Alloys*, Vol. 5, May 1934, page MA 174. FR (3a)

Foundry Bronzes.—No. II. Lead Bronzes. *Foundry Trade Journal*, Vol. 50, Feb. 15, 1934, page 116. Article discusses melting-shop and foundry practice in connection with manufacture of bronzes containing up to 30% Pb. OWE (3a)

Deoxidation of Technical Silver Melts (Die Deoxydation technischer Silberschmelzen). K. W. FROEHLICH. *Mitteilungen des Forschungsinstituts und Probieramts für Edelmetalle*, Vol. 7, Feb. 1934, pages 132-135. Results of former investigations are recapitulated. P is the cheapest and also the most economical deoxidation agent. The most advantageous form in which to use it is as phosphor copper because of its easy pourability; furthermore, hydrogen disease will not occur during bright-annealing; elongation and deep drawability are considerably improved while tensile strength and hardness are lowered very little. By its addition intermediate annealing between rolling, drawing, etc., can be of shorter duration and the more so, the more P remains in the alloy. Another important factor is that P-containing Ag-Cu alloys are not easily attacked by acid food stuffs. On the other hand, care must be taken not to heat such alloys over 646° C. in intermediary annealing as red-brittleness follows. If P-containing Ag-Cu alloys are to be Ag plated they must not be degreased electrolytically except with boiling soda lye, as no satisfactory electrolytic deposit can be obtained on an electrolytically degreased surface. The procedure of deoxidizing with P-Cu is briefly described. Ha (3a)

Aluminum Bronze Improved by Vacuum Die Casting. *Iron Age*, Vol. 133, Jan. 25, 1934, page 29. Describes a vacuum die casting process for Al bronze production. Claims that parts are uniform in composition, strength, hardness and heat resisting properties, and free from inclusions. VSP (3a)

Ferrous (3b)

C. H. HERTY, SECTION EDITOR

1 **Scrap-Iron as Raw Material for Steel Production in the Open-Hearth Furnace (Alteisen als Rohstoff für die Stahlerzeugung im Siemens-Martin-öfen).** R. HENNECKE. *Zeitschrift Verein deutscher Ingenieure*, Vol. 78, Mar. 24, 1934, pages 369-373. The economical importance of using scrap is pointed out. By scrap is understood old iron and steel which is returned after years of use, not the scrap material available from processes in the plant. When scrap is properly treated, especially foreign metals and non-metals carefully removed, a steel fully equal to new material can be produced as tensile tests and deep-drawing samples have proved if the working process is adapted to the kind of scrap. O and S can be made harmless effectively by high temperatures and high lime in the slag. Ha (3b)

2 **Example of Maufacture of a Chilled Casting (Un Example de Fabrication de Fonte coquillée).** L. GASQUARD. *Revue de Fonderie Moderne*, Vol. 28, Apr. 25, 1934, pages 115-117. Describes procedure of casting runners of a very hard cast iron in a chill mold; C content 3%, Si high; cast at low temperature by letting the metal cool slowly from melting temperature. Ha (3b)

3 **Making Carbon Tool Steel in Basic Electric Furnaces.** J. A. SCHULTE. *Domez*, No. 10, 1933, pages 53-59. In Russian. High P scrap (0.060-0.10%) can be reduced before the charge is melted down to 0.030-0.040% P by placing in charging layers of lime between the successive layers of scrap. The amount of lime equal at least to 4% of the weight of the metallic charge should be used. Either white slag with ferrosilicon addition or carbide slag are suitable for finishing the heat. A thorough removal of H_2 and N_2 requires at least one hour boiling before first slagging. Four parts of lime, one of fluorspar and one of coke is used for carbide slag. Carbide slag finishing produces steel much less sensitive to quenching temperature variations than white slag. Before applying to an order the quenching properties of steel are determined by forging the ladle test at a correct temperature, annealing at a standard temperature to remove internal stresses, quenching from a specified temperature range and fracturing. The appearance of the fracture is classified according to the depth of penetration and shape of the core. Tables used for the purpose in Germany and Russia are given together with the explanation of the system underlying it and examples of actual fractures. Mn and Si higher than 0.25% increase the depth of penetration. V and Al greatly decrease it, so that addition of Al to carbon tool steel must be considered as necessary. Carbide slag practically assures a quenching range of 100°C.-120°C. (sic!) Melting sheet of one heat is given. (3b)

4 **Manganese and Phosphorus Equilibria in the Open-Hearth Furnace in the Light of Newer Temperature Measurements Part I (Das Mangan- und Phosphorgleichgewicht im Siemens-Marten-Ofen im Lichte neuerer Temperaturmessungen. I.)** C. SCHWARZ, E. SCHRÖDER & G. LEIBER. *Archiv für das Eisenhüttenwesen*, Vol. 7, Sept. 1933, pages 165-174. An exhaustive discussion of previous work on the Mn and P equilibrium constants in the basic open-hearth as affected by temperature, with corrections based on the recent work of E. Schröder (*Archiv für das Eisenhüttenwesen*, Vol. 7, 1933, pages 157-164) indicating that previously assumed temperatures were somewhat low. Finally selected values for the Mn and P equilibrium constants are given as follows:

5 $$\log K_{Mn} = \log \left(\frac{Fe}{Mn}\right). Mn = -\frac{5920}{T} - 0.332 \frac{T}{1000} + 1.778 B (0.956 - B) + 3.0263. \text{Log } K_P = \log \frac{P2}{(P_2O_5)}. (Fe)^5. B^3 = -\frac{24000}{T} + 3.62.$$

For both the above reactions the basicity of the slag is taken as B = 0.01 (% CaO — 0.93·% SiO_2 — 1.175·% P_2O_5). SE (3b)

6 **Desulphurization with Soda or Refining Briquettes "Walter" (Entschwefelung mit Soda oder Raffinationsmittel "Walter")** SCHUMACHER. *Zeitschrift für die gesamte Giessereipraxis*, Vol. 55, Jan. 21, 1934, pages 30-31. According to method patented by Walter cast Fe is desulphurized by a second alkaline slag which removes within short time time SiO_2 and other oxides and gases as well as S. Walter uses molten soda in shape of briquettes that melt on metal bath 5 times as fast as pulverized soda. Walter's method has been imitated using pulverized soda that offers considerable disadvantages. Success of desulphurization depends on absence of acid slags in slags formed during melting down period. GN (3b)

7 **Casting Cast Iron Ingot Molds in Chills.** I. A. SIGOV. *Domez*, No. 10, 1933, pages 48-52. In Russian. Big end down straight wall ingot molds weighing 680 kgs. and having 10 cm. wall thickness were cast in chills weighing 1800 kgs. Stool for the chill was provided with impression for the core print of the sand core permitting accurate centering. Top pouring was used. Iron with 1.5 Si max. and 1.0 Mn max. was taken either from cupola or reverberatory. Average life of the first lot of 70 was 190 heats. Less carefully made production ingot molds averaged 130 heats, based on two year data. Chills stood more than 300 castings. (3b)

An Intricate Casting. *Engineer*, Vol. 156, Nov. 24, 1933, page 530. Gives short description and illustration of one of 3 castings made by the English Steel Corporation to be used as the main pump bedplate for an hydraulic high-pressure pump. The finished casting was 22 ft. 6 in. long, 7 ft. 4 in. wide and 6 ft. deep. In making this 70 different types of core were used. LFM (3b)

8 **Cylindrical Loam Cores (Noyaux Cylindriques en Terre)** Technical Committee of the Belgium Foundry Association. *La Fonderie Belge*, Vol. 2, Jan. 1933, pages 1-4. In this section manufacture of a large core of 2.5 m. diameter and 4 m. length is described. Devices and appliances for sweeping this large core are illustrated on 2 drawings. FR (3b)

Centrifugally Cast Iron Pipe. *Gas Engineer*, Vol. 58, Dec. 1933, page 608. Illustrates and describes the practice at the Stanton Ironworks Co., Ltd., according to the de Lavaud process. Production per man is 250% greater than by the old sand-cast method. The pipes are cast in chill molds and subsequently annealed at 1750° F. They are kept revolving to keep them from bending. This is continued in the cooling chamber down to 600° F. WH (3b)

9 **Sodium Carbonate in the Foundry.** *Metal Industry*, London, Vol. 43, July 7, 1933, page 17. The use of soda ash in the foundry for producing homogeneous castings, especially gray iron, is recommended. It melts at 851° C. and dissociates with the liberation of CO_2 gas which causes a boiling action in the melt so that the whole of the Fe comes into intimate contact with the fluid soda slag. By the time tapping ceases the boiling action has partially subsided but sufficient movement remains in the metal to separate the suspended silicates, oxides and other non-metallic matter from the molten mass and carry them to the top as slag. Ha (3b)

Open-Hearth Operators Start Plant Rehabilitation. *Steel*, Vol. 93, July 10, 1933, pages 28-29, 31. Report of the 16th semi-annual meeting of the Open-hearth Committee, American Institute of Mining and Metallurgical Engineers. Among the subjects discussed were ladle nozzles and stopper-rod assemblies; combustion control for open-hearth furnaces; scrap situation; residual metals in steel; use of coke in open-hearth charge; insulation of furnaces; inclusions in steel; production of rimming steel; stabilized deep drawing steel; evaluation of dolomite; and design of a 150-ton open-hearth furnace. MS (3b)

10 **Investigates Effect of Iron Oxide in Open-Hearth Slag.** *Steel*, Vol. 93, Oct. 30, 1933, pages 29-31. Report of the 7th open meeting of the Metallurgical Advisory Board, Carnegie Institute of Technology, Oct. 20, 1933. Devoted chiefly to work of C. H. Herty, Jr., on control of iron oxide in slags and on the effect of deoxidation on the aging of mild steel. MS (3b)

PURE CARBIDE-FREE

metals

Tungsten Powder.... 97-98%
Pure Manganese 97-99%
Ferro-Chromium 60%
Pure Chromium 98-99%
Ferro-Tungsten 75-80%
Ferro-Titanium 25% and 40%
Ferro-Vanadium 35-40%

Send for Pamphlet No. 2025

Metal & Thermit Corp.

120 BROADWAY, NEW YORK, N. Y.

Albany ★ Pittsburgh ★ Chicago
South San Francisco ★ Toronto

Terminology Relating to Non-metallic Elements in Metals. T. D. YENSEN & C. H. HERTY. *Metals Technology*, June 1934, *American Institute Mining & Metallurgical Engineers, Technical Publication* No. 555, 13 pages. The manner in which gases and non-metallic elements may occur in metals is discussed. It is recommended that the term "gases in metals" be confined to elements or substances existing in the metal in the gaseous state. The term "Non-metallic metallic elements introduced into metals unintentionally or for various definite purposes (O, N, C. S. P, etc.), and (2) Phenomena occurring in metals caused by non-metallic elements. Discussions of the recommendations by different workers in the field are included. JLG (3b)

A Foundry Defect: The "White Spot" in Heavy Cast Iron Castings (Un Défaut de fonderie : Le Blanc des Grosses Pièces de Fonte) A. LE THOMAS. *La Fonte*, Vol. 2, Jan. 1933, pages 254-259. Defect dealt with can be described as follows: after shaking out, casting shows normal appearance but after any shock a white crust separates from the casting leaving a dirty area. This defect lies in the vicinity of inside corners at upper part of the casting. This defect is not regularly met, it can appear on few castings and then disappear completely during some time. Conditions observed which favor defect formation are: (1) High casting temperature of heavy castings with inside corners. (2) Cast iron with too high Si and S contents and too low a Mn content. (3) Unsufficiently refractory sand or blacking. After a study described in the article, author explains as follows defect formation: MnS present in high quantity rises with dross and graphite up to the surface, the thicker the layer of these materials the slower the cooling. MnS and perhaps graphite oxidize progressively with O from dross and then from air coming through the sand, this involves heat formation which can produce a reaction between MnO and FeO of dross which are basic and silica of mold sand which is acid, this will of course take place in spots most heated, i. e., on inside angles of the casting. It would be possible to suppress this kind of defect by decreasing Si content through steel scrap additions and by decreasing S content through Mn addition which favors elimination of MnS in cupola crucible and in pouring ladles. FR (3b)

An Investigation of the Phenomenon of an Artificial Bonded Molding Sand "Burning onto" Steel Castings. W. E. STEWART. Master of Science Thesis, Carnegie Institute of Technology, Apr. 12, 1933, 78 typed pages, 13 plates. Unpublished, available at Carnegie Institute of Technology Library. The permeability and bonding strength both in shear and compression under green and dry sand conditions of a natural bonded molding sand were studied with a view to duplicating these properties in a washed silica sand mixture bonded with a refractory fire clay. From the soundness and from the ease of cleaning of castings produced in molds from these sands it was endeavored to determine whether by controlling the physical properties of an artificially bonded molding sand mixture the phenomenon of "burning in" on large steel castings may be eliminated. Accordingly, from about 83 sand mixtures whose properties were measured, one mixture containing 83 to 85% (-10 + 20 mesh) Dunbar sand, 8 to 10% Negley clay, 5 to 9% silica flour and 5.5 to 6.0% water was selected for "burning in" tests. The phenomenon of "burning in" was considered as related to the physical properties and refractoriness of the bonded silica sand mixture. Factors as affecting the "burning in" were listed as (1) amount and distribution of the clay, its refractory and plastic qualities, (2) the size of sand grains as affecting permeability, (3) the amount of tempering water and (4) the temperature of the steel poured. The current literature is ably reviewed. HWG (3b)

Formation of Graphite Nuclei in Cast Iron (Die Graphitkeimbildung in Gusseisen) E. SCHEIL, W. RUFF & E. H. SCHULZ. *Archiv für das Eisenhüttenwesen*, Vol. 7, Dec. 1933, pages 333-335. Undercooling increases the number of graphite nuclei, but decreases their size. Thus the surface of cast iron has a greater tendency to solidify white than the interior, despite the greater number of graphite nuclei at the surface. Oxygen tends to increase the number of graphite nuclei. SE (3b)

Courtesy Youngstown Sheet & Tube Company

NIAGARA
BRAND
FERRO-ALLOYS
Assure Quality Steel

FERRO-SILICON
ALL GRADES

FERRO-CHROMIUM
HIGH CARBON

FERRO-CHROMIUM
LOW CARBON

FERRO-MANGANESE

SILICO-MANGANESE

◆

PITTSBURGH METALLURGICAL CO., Inc.

NIAGARA FALLS, N. Y.

WORKING OF METALS & ALLOYS (4)

Influence of Forming Process upon Preferred Orientations in Wires (Über den Einfluss des Formgebungsverfahrens auf die Kristallgleichrichtung in Drähten). G. v. VARGHA & G. WASSERMANN. *Zeitschrift für Metallkunde*, Vol. 25, Dec. 1933, pages 310-313. Studies of preferred orientations in wires have been performed only upon wires formed by drawing; a comparative study is made here upon the preferred orientations in both drawn and rolled wires. Copper wires were rolled from a diameter of 15 mm. to a diameter of 2 mm.; these were etched to a diameter of 0.5 mm. for study, since the interior of wires possesses the best fiber structure. X-ray photograms are given of rolled and drawn wires. These photograms show identical fiber structures, namely with the direction [111] and to some extent [100] parallel to the wire axis. Al and Fe wires gave the same result. Wires of a β Cu-Zn alloy (previously uninvestigated) showed a fiber structure characteristic of body-centered cubic metals, with the [110] direction parallel to the wire axis. The fiber structure in the fracture cone of a Cu bar broken in tension is identical with that in drawn wires. These results show that the methods adopted to secure form changes are of no importance but that the type of form change alone is important in determining the type of preferred orientation developed in the center of the deformed piece. The difference in forming methods is, however, shown in the fiber structures developed on the surface. The orientations developed in drawn wires show rotational symmetry, whereas in rolled wires, as might be expected, the orientations in the surface show an irregular distribution owing to the irregularites in the rolling process. RFM (4)

Rolling (4a)

RICHARD RIMBACH, SECTION EDITOR

The Manufacture of Full-finished Steel Sheets. ERIC R. MORT. *Iron & Steel Institute, Advance Copy* No. 12, May 1934, 39 pages; *Sheet Metal Industries*, Vol. 8, June 1934, pages 331-336; *Engineering*, Vol. 137, June 15, 1934, pages 689-692; June 29, 1934, pages 741-743. A rather detailed discussion of present-day methods of American sheet-mill and wide-strip-mill practice is given. English sheet mill practice is compared with these. The Steckel hot mill is described. Relative advantages of 4-high cold mills and wide strip mills are discussed. On account of the cost of wide strip mills equipped for tandem rolling and the difficulty with this equipment of handling small orders the reversing 4-high cold mill is probably the more economical. 16 references. JLG (4a)

Work Expended in Rolling Soft Steel Sheet as Affected by the Thickness of the Sheet and the Silicon Content (Die Verformungsarbeit beim Auswalzen von Flussstahlplatinen in Abhängigkeit von der Platinenstärke und dem Siliziumgehalt). A. WEYEL. *Stahl und Eisen*, Vol. 54, March 22, 1934, pages 281-287. The rate at which the work expended increases as the sheet becomes thinner is shown in curves. With increasing Si content the work expended increases up to 1% Si and then remains constant up to 2.4% Si, with further increase in Si, however, the work expended decreases again until at 4% Si it is the same as in soft iron without Si. SE (4a)

Technical Progress in American Sheet Mills (Technische Fortschritte im amerikanischen Feinblechwalzwerk). H. KLEIN. *Stahl und Eisen*, May 31, 1934, pages 543-553. A detailed illustrated account of the most recent developments in design, operation, and relative efficiency of American sheet and continuous strip mills and of their applicability to German conditions. 23 references. SE (4a)

Automatic Rolling Mill for Spring Steel with Slow Cooling (Selbstätiges Walzwerk für Federstahl mit langsamer Abkühlung der Walzstäbe). R. LINZ. *Stahl und Eisen*, Vol. 54, May 1931, pages 573-576. The layout of the mill is shown. Slow cooling below the critical temperature was obtained by piling the rolled bars until they had cooled below 400° to 500° C. SE (4a)

Wire Rod Mill Proposed for the U. S. S. R. I. G. KONSTANTINOV. *Iron Age*, Vol. 133, Apr. 19, 1934, pages 12-13, 74. Discussion of the continuous and Garrett mills, their advantages and disadvantages. Following items were taken into consideration: Working crew; maximum wt. of bundle feasible; section uniformity of initial and final end of rod; power consumption per ton of material rolled; accuracy of rolled section; cost of mill; and mill capacity. Gives a summary covering equipment necessary, including additional finish stands, applying it to semi-continuous wire rod mill to be erected at Magnitogorsky. VSP (4a)

New Inland Tin Plate Now in Operation. *Iron Age*, Vol. 133, Mar. 1, 1934, pages 16-18. Describes mill installed at the Indiana Harbor plant of Inland Steel Co. Mill is capable of rolling material 36 in. wide to No. 38 gage or 55 lb. tin plate. Company has also installed a 38 in. Steckel mill for light wt. material. Capacity of the units will probably be 10,000 tons per month. VSP (4a)

Service Quality and Structure of Sheet Mill and Grooved Rolls. I. E. BRAININ & K. B. BARANOV. *Domez*, No. 1, 1934, pages 27-35. (In Russian). Frequent breaking of the rolls caused the investigation of their quality, which showed that breakage was due to carelessness in rolling. (4a)

Rolling of Ingots (Della trasformazione di lingotti in lamiere). L. MORANDI. *La Metallurgia Italiana*, Vol. 26, Feb. 1934, pages 81-116. A mathematical paper. The forces required, speed of operation of the rolling mills, and energy consumption, in preparing sheets of required thickness from ingots are considered in detail. AWC (4a)

Roll Design. A. P. CHEKMAREV. *Domez*, 1934, No. 2-3, pages 45-47 (In Russian). Four methods for roll design can be used; based on the maximum grip angle, on elongations in the passes, on the reduction of the cross section and on the amount of power consumed in each pass. (4a)

Comments on Paper by P. Emeljanenko "The Basis for Roll Design of Pilger Mills." A. ROSENBAUM. *Domez*, 1934, No. 2-3, pages 62-66. (In Russian) Polemical. (4a)

Extreme Pressure Lubricants Afford High Power Transmission through Bearings. C. M. LARSON. *Steel*, Vol. 94, May 28, 1934, page 55. Outlines principal requirements of extreme pressure lubricants for roller bearings of roll necks of modern high-speed mills. MS (4a)

Variation of Substance in Tinplate. J. SELWYN CASWELL. *Blast Furnace & Steel Plant*, Vol. 22, Feb. 1934, page 122; Mar. 1934, page 178; Apr. 1934, page 234. From *South Wales Evening Post*. College of Engineering of Swansea University has investigated production systems in relation to variations in gage of tin-plate. Principal defects in many of the systems are confined to the preliminary and final stages of production. Under present methods, hot rolling has too large an influence in determining the final substance and oversheet variations. Present cold-rolling practice does not meet this need adequately. Greater precision in the final stages is necessary, and if preceded by improvements in the preliminary stages and in the methods of rolling, approach to correct and uniform substance would be better. MS (4a)

Forging & Extruding (4b)

A. W. DEMMLER, SECTION EDITOR

Problems in Designing for Die Castings. M. G. DEMOUGEOT. *Product Engineering*, Vol. 5, Apr. 1934, pages 130-132. Explains the methods of die-casting small parts of hand-operated printing and initial n„ machines. Ha (4b)

Luminous Flame Forging With Gas. J. B. NEALEY. *Iron Age*, Vol. 133, Mar. 22, 1934, pages 18-20, 74. Describes various forms of burners used by Pgh. Forgings Co. for heating steel with gas fuel without forming scale. Forges equipped with luminous radiant flame burners will not only bring steel to temp. of 2300° to 2400° F. without producing scale but will do this at high speed. Rapid heating is attained because flame radiates heat. Effective range of flame is entire length of furnace. Non-scaling characteristic is derived partly from the fact that no excess air is used. VSP (4b)

Turning Old Armor Plate into Forging Dies. B. M. SUSLOV. *Metal Progress*, Vol. 25, June 1934, page 48. Describes salvage of naval scrap for the production of forging dies. Steels of C 0.31, Cr 2.3, Ni 3.9, Mn 0.3, and Si 0.02% and Cr 1.08, Ni 2.5, Mn 0.56 and Si 0.23% have given very satisfactory results when applied to such uses. WLC (4b)

A Few Notes on Forging Machines. ARTHUR LORD. *Railway Engineer*, Vol. 54, Dec. 1933, pages 374-375. Forging machines widely used in America and Germany are also coming into use in England. Forging cheapens production particularly in the case of large quantities and thus replaces malleable Fe or steel castings. The intense forging stress makes the material more homogeneous and better able to withstand high stresses. The extending utilization of forging in railway shops includes wagon brake shafts, side plungers, shackles, brake pull rods, signal joints, brake shaft hinges, rocker bars, wagon spring and buffer ends, and hollow forgings. WH (4b)

Relation between Ingot Structure, Degree of Forging, and Properties of two Structural Steels (Beziehungen zwischen Primärgefüge, Verschmiedung und Gütewerten bei zwei Baustählen). H. VOSS. *Archiv für das Eisenhüttenwesen*, Vol. 7, Jan. 1934, pages 403-406. Ingots of 0.15% C, 0.97% Cr, 3.7% Ni steel and 0.35% C, 1.25% Cr, 0.20% Mo steel were reduced 70 fold by forging, tension and impact tests made, and the relation between the final structure and the original ingot structure studied. The forging changed the tensile strength very little. The elongation, reduction of area and impact resistance increased in the longitudinal direction; in the transverse direction there was sometimes a decrease, sometimes an increase. The ratio of transverse to longitudinal impact resistance was considerably lowered with forging reductions up to about 10 fold but for further reductions, the ratio remained fairly constant. The grain size decreased continuously with the amount of reduction. SE (4b)

Drawing & Stamping (4c)

Modern Wire-Drawing (Moderne Metalldrahtziehereien). C[illegible]. BERNHOEFT. *Zeitschrift für Metallkunde*, Vol. 25, June 1933, pages 125-127. A discussion of proper procedures for drawing heavy and fine wires and of the necessary equipment. Data are given on the necessary drawing forces with wires of different dimensions, and on the most favorable drawing velocities. RFM (4c)

Progress in Manufacture and Use of Wire and Wire Products. F. H. NULLMEYER. *Steel*, Vol. 94, Mar. 12, 1934, pages 25-27; Mar. 19, 1934, pages 48, 50-51, 53; Mar. 26, 1934, pages 45, 47, 50, Apr. 2, 1934, pages 45, 47-48. Outlines early developments in wire-drawing and discusses recent trends in rod-mill design and practice, methods of cleaning and pickling, methods and equipment for wiredrawing, and wiredrawing dies and lubricants. List many uses of wire. MS (4c)

The Manufacture, Testing, and Uses of Steel Wire. J. DENNIS ROBINSON. *Inspection*, Vol. 5, Jan. 1934, pages 30-41. Paper read before the N. E. Coast Branch of the Institution of Engineering Inspection. Historical review. Treatment of wire before drawing and discussion of drawing process. Shapes of wire-drawing dies and material used for their manufacture are dealt with. Physical characteristics and chemical composition of wire-steels and the influence of different components on the drawing process are discussed. Annealing. Dealing with patenting processes, their influence of physical properties of the fire are pointed out. In conclusion causes of failure, testing methods and various uses of wire are discussed. Kz (4c)

Tool Steel for Press Operations. A. R. PAGE. *Heat Treating & Forging*, Vol. 20, Mar. 1934, pages 134-137. See *Metals & Alloys*, Vol. 5, May 1934, page MA 182. MS (4c)

Stamping Automobile Parts of Stainless Sheet. J. L. MCCLOUD. *Metal Progress*, Vol. 24, Nov. 1933, pages 23-26. Describes commercial methods of producing stainless stamping for automobile parts. WLC (4c)

Chevrolet Uses Special Equipment To Make Wire Wheels. *Iron Age*, Vol. 133, May 24, 1934, pages 16-20. Describes ingenious arrangement of machinery in a comparatively small floor space and novel use of conveying equipment. Modern machine tools makes economical production possible. Unusual stamping operations are achieved through variation in design of presses and dies of special design 600 wheels an hr. are made. VSP (4c)

Furnaces in Wire Drawing Plant. J. B. NEALEY. *Heat Treating & Forging*, Vol. 20, June 1934, pages 299-300. Describes equipment and practice of the Belden Manufacturing Co., Chicago, for the manufacture of fine Cu wire. Alloy steel dies are used for larger gages and diamond dies for the finer gages and for finishing. Drawing machines are equipped with step cone rolls. Gas is used for heating insulated cylindrical steel annealing furnaces, with steam atmosphere and H_2O seal; drying oven, with separate heater; tinning pots; and ovens for baking enamel. MS (4c)

Wire Drawing of Steel (Le trefilage de l'acier). MAURICE BONZEL. Dunod, 92 Rue Bonaparte, Paris, France, 1934. Paper, 6½ x 10, 638 pages. Price 146 Fr.

A very complete discussion of all phases of the subject, by the manager of a French wire plant. Starting with the rolled rod, whose possible defects are discussed, the process is described in detail. Dies, their composition, design and maintenance, their lubrication (70 pages are devoted to lubrication) and many mechanical details of the equipment are discussed. The effect of cold work on the properties of wire of varying composition, of annealing and of patenting and other types of heat treatment on high carbon wire are dealt with from the metallurgical point of view. Annealing and bright annealing furnaces and procedure, pickling, galvanizing are all discussed. There is a chapter on works organization.

A considerable amount of data is quoted from the literature, but the author has plenty of data of his own to illustrate his points. The book is very complete and authoritative. H. W. Gillett (4c)—8—

Ford Makes Starters and Generators in Model Small Plant. BURNHAM FINNEY. *Iron Age*, Vol. 132, Nov. 9, 1933, pages 10-14, 60. Describes facilities for making starters and generators at the Ford Motor Co.'s Ypsilanti, Mich., plant. Outlines method of stamping, welding, machining, soldering, baking and testing operations. Of particular interest is the continuous mill used for rolling Cu bars into strips. VSP (4c)

Basic Open-Hearth Carbon Steel for Cold Heating—"Ingot to Wire." A. B. ARGANBRIGHT. *Transactions American Society for Metals*, Vol. 22, May 1934, pages 471-480; *Iron & Coal Trades Review*, Vol. 127, Nov. 17, 1933, page 762. Describes the history kept through the several steps in the manufacture of cold heading wire from rimmed steel ingots. Methods of inspection and times in processing when they are applied to give quality are described. WLC + Ha (4c)

Machining (4d)

H. W. GRAHAM, SECTION EDITOR

Trends in Machine Tool Design. J. H. WRIGHT. *Institution of Production Engineers*, Vol. 13, Mar. 1934, pages 117-141; *Machinery*, London, Vol. 43, Nov. 16, 1933, pages 202-204, Nov. 23, 1933, pages 223-225. Paper presented to the Institution of Production Engineers, Birmingham Section. Developments in light alloys and cutting materials have tended to a general demand for machines suitable for higher speeds. Recent developments in each of the chief elements of design are discussed, with examples illustrating modern practice. Improvements offering greater convenience, time and effort saving, increased accuracy and durability are dealt with. Kz (4d) 1

High Speed Tool Steels in Railway Machine Shops. R. G. WOODWARD. *Railway Engineer*, Vol. 54, Dec. 1933, pages 373-374. The increase of cutting speeds show: original high C tool steel = 16 ft./min., Mushet self-hardening steel = 26 ft./min., modern high-speed steel = 100 ft./min. The heat treatment of the latter type of steel is given. Besides the advance of cutting materials, the improved design of cutting tools is discussed. WH (4d) 2

Machinery Die Cast Aluminum—A Precision Job in Making Picture Projectors. C. A. ZIEBARTH, *Iron Age*, Vol. 133, April 1934, pages 14-19. Describes the manufacture of motion picture equipment and accessories by Bell & Howell Co., Chicago. Castings are made of specifications by jobbing shop. Composition of castings is designated as No. 12 alloy consisting of 92% Al and 8% Cu. Die castings are carefully machined to assure absolute interchangeability. A total of 43 operations on a 14 oz. die casting removes a total of 1.1 oz. VSP (4d) 3

Grinding Direct From the Drawing. OLIVER P. VAN STEEWEN. *Sheet Metal Industries*, Vol. 7, Nov. 1933, pages 414-416. Discusses a new profile grinder developed by Messrs. Loewe Gesfurel of Berlin. The grinding operation and constructional details are explained. AWM (4d) 4

Influence of the Conditions of Finish Cutting on the Surface Appearance (Einfluss der Schnittbedingungen beim Schlichten auf das Oberflächenaussehen). A. WALLICHS & R. FRANK. *Archiv für das Eisenhüttenwesen*, Vol. 7, Jan. 1934, pages 417-422. The cutting tests (turning) were made on several carbon structural steels and on a 61.8 Cu, 36.2 Zn, 1.5 Fe, 0.13 Sn, 0.04 Pb, brass. At the lowest cutting speeds no grooving occurred and the surface was very smooth. As the speed was increased the surface became rougher till the "critical cutting speed" was reached after which the surface again became smoother, but not so smooth as below the critical cutting speed. With an emulsion the surface was smoother than on cutting dry, but rapeseed oil was without effect. The critical cutting speed is greater the smaller the feed and the lower the tensile strength of the work. For smooth surface it is best to cut somewhat below the "critical speed," generally at about 4 to 6 m./min. SE (4d)

Special Planing Machine (Sonderhobelmaschine mit beweglichem Hobelwerkzeug). F. SIPMANN. *Zeitschrift Verein deutscher Ingenieure*, Vol. 78, June 2, 1934, page 617. Description of machine for planing locomotive frames of maximum 14 m. length, cutting velocities from 5-25 m./min. and cutting force of 6000 kg. at all velocities. Ha (4d) 5

Machine Tools for Locomotive Production. B. C. WHITE. *Railway Engineer*, Vol. 54, Dec. 1933, pages 368-369. The advances of (1) boring and drilling and (2) planing and milling machines with reference to their utilization as machine tools for locomotive production are discussed. WH (4d)

Profits in Cutting Tools. F. B. SCOTT. *Mill & Factory*, Vol. 14, May 1934, pages 29-30. Deals with the application of modern machines and cutting tools under average shop conditions. Data, given in a cutting chart, are based on results obtained from practical experience. Kz (4d)

Slotting and Milling in Railway Work. W. OWEN. *Railway Engineer*, Vol. 54, Dec. 1933, pages 372-373, pages 379-380. The utilization of puncher slotting machines instead of milling machines is discussed. The former is able to take enormously heavy cuts from rough steel forgings and nevertheless leaves an excellent finish. The considerable impetus due to the introduction of W carbide tools is stressed and some of the latest types of British puncher slotting machines are shown. WH (4d) 6

Giant Boring Mill Used on Large Turbine and Generator. M. M. MCCALL. *Iron Age*, Vol. 133, Mar. 1, 1934, pages 12-15. Describes a boring and turning mill installed at Milwaukee plant of Allis-Chalmers Mfg. Co. The machine has a swing of 40 ft. 4 in., maximum height of 16 ft. 3 in. and weighs 1,040,000 lb. It was built by Niles Tool Works Co. data on table speed control, and the making of table, bed and other members in sections. VSP (4d)

European Tool Steels Vary Somewhat from American. FEDERICO GIOLITTI. *Metal Progress*, Vol. 25, June 1934, page 54. 0.15% Cr of American special tool steels is not used in Europe. 0.6% is used with 1.1-1.2% C. Non-deforming type tool steels in Europe contain W 0.6-0.8%, V 0.15-0.3% with or without 0.6% Cr and Mn 1.5-2.0%. In high speed steels Cr 4.5% and higher are prevalent in Europe with 2.0% V. C content tends to be higher with normal 0.72-0.80%. Co is used in increasing quantities and in proportions higher than 14%. WLC (4d) 7

Large Water Gates Machined by Specially Adapted Equipment. D. B. CHARTERS. *Iron Age*, Vol. 133, Jan. 25, 1934, pages 12-16. Describes unusual difficulties in machinery due to large size and weight of gates and accuracy required. Some ingenious adaptations of existing machine tools and assembly equipment devised by Westinghouse Electric Mfg. Co. are dealt with. VSP (4d) 8

New High-Speed Cutting Tools May Revolutionize Plant Expansion. PHILIP E. BLISS. *Steel*, Vol. 94, June 11, 1934, page 46. Due to the greatly increased efficiency afforded by modern cutting tools, such as the tungsten carbide tools, plants wishing to expand their productive capacity may do so, without increasing floor space and equipment, simply by replacing their present metal working equipment with modern machines. MS (4d)

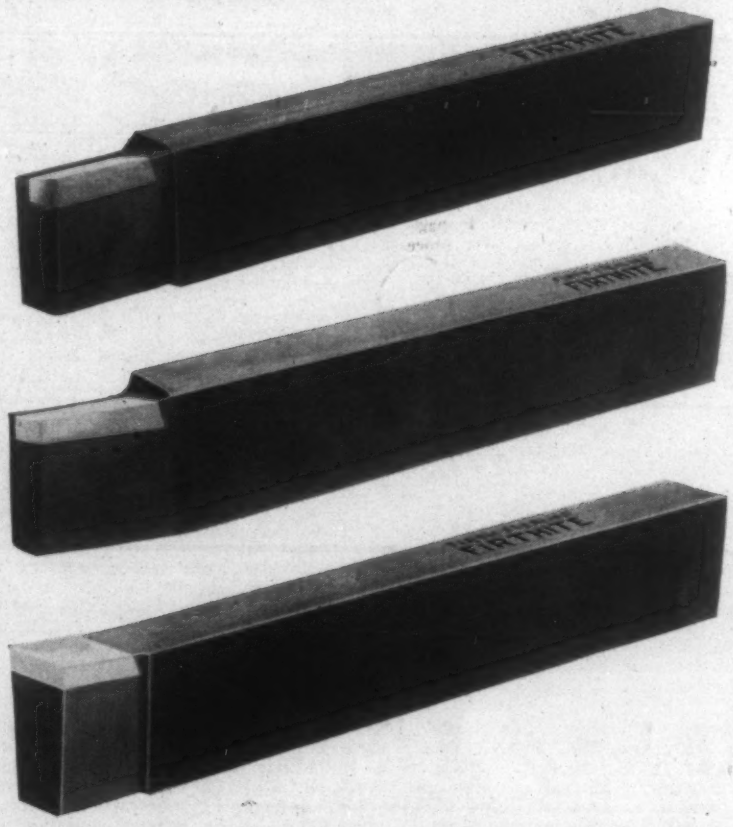
Cutting and its Application in Practice (La Science de l'Enlèvement des Copeaux et son Utilisation dans la Pratique). M. KRONENBERG. *Science et Industrie*, Vol. 18, Mar. 1934, pages 82-85. Article deals with following subjects (1) cutting speed, (2) cutting pressure, (3) mechanical work, (4) tables FR (4d) 9

Controlled Cooling to Promote Machinability. O. W. MCMULLAN. *Metal Progress*, Vol. 24, Sept. 1933, pages 25-28. Appearance of small patches of martensite in normalized SAE 4615 Ni-Mo steel is described. This structure is not encountered in all heats of this steel but when met results in difficult machining. 22 different cooling cycles were tried to eliminate this structure. With a treatment holding 2 hrs. at 1800° F. and cooling in a furnace of 800° F. to that temperature and holding 15 min. and cooling in air resulted in Brinell of 163 on good cutting heats and 187 on poor cutting heats with entire absence of banding or martensite in either type of heats. WLC (4d)

Martensitic Grains in Air-Cooled Low Carbon Steel and Their Effect on Machinability. O. W. MCMULLAN. *Transactions American Society for Steel Treating*, Vol. 21, Nov. 1933, pages 1035-1060 with discussion. In discussion E. F. Thum brings out that McMullan has found a disease and cure and suggests that the steel makers look into the cause and prevention of the disease. O. W. Boston comments upon the criteria of machinability. WLC (4d) 10

FIRTHITE

SINTERED CARBIDE CUTTING TOOLS



TO secure the full benefit of all economies possible with modern machine tools use Firthite Cutting Tools. Out-of-date cutting materials jeopardize expected economies and savings while Firthite assures them.

New Firthite Tools are the most advanced cutting material obtainable and permit the highest speeds, with greater accuracy and finer finish on machining operations such as: turning, milling, boring, or drilling, non-ferrous metals, cast irons or hard steels, bakelite, rubber, asbestos, and other abrasive products.

An order for a standard Firthite Sintered Carbide Tool to be used on your regular or repair jobs will convince you of the savings possible through the use of this material. Try one or two tools, they may solve your cutting problems.

FIRTH-STERLING STEEL COMPANY

General Offices and Works: McKEESPORT, PA.

Branch Warehouses:

NEW YORK HARTFORD PHILADELPHIA DETROIT
CHICAGO CLEVELAND LOS ANGELES

HEAT TREATMENT (5)

O. E. HARDER, SECTION EDITOR

Heat Treating and Carburizing at National Acme Plant. F. L. PRENTISS. *Iron Age*, Vol. 132, Oct. 12, 1933, pages 14-17, 74. Describes the heat treating and carburizing procedure by the National Acme Co., Cleveland. All heat treating facilities have been combined into one department. Features of the plant include the conversion of a fuel-fired furnace into an electric one, using stainless Fe electrodes and electric furnace natural gas carburizing equipment. VSP (5)

Heat Treatment Contributes to Accurate Bores. J. B. NEALEY. *American Machinist*, Vol. 78, May 9, 1934, pages 340-341. The equipment of a heat-treating plant is described; parts of alloy steels are carburized, heat-treated and drawn to Rockwell hardness 55-60, after which they are finish-machined and ground. Ha (5)

Heading and Heat Treating Bolts. J. B. NEALEY. *Heat Treating & Forging*, Vol. 20, Feb. 1934, pages 80-81, 84. **Special Furnaces Built for Heating Bolt, Nut Stock.** *Steel*, Vol. 94, Feb. 26, 1934, pages 21-23. See *Metals & Alloys*, Vol. 5, June 1934, page MA 256. MS (5)

The Heat Treatment of Cast Iron. CARL H. MORKEN. *Transactions American Society for Metals*, Vol. 22, Mar. 1934, pages 227-248. Malleableizing treatment for white cast iron are reviewed. It is claimed that heat treated white iron made in electric furnace can be produced with strength of 100,000 lbs./in.^{2} and modules of elasticity of up to 5,000,000. Applications of heat treated cast iron to cam and crank shafts are cited. In discussion E. L. Roth and H. Bornstem bring out the fact that high strength iron can be produced from cupola metal as well as electric furnace metal. WLC (5)

Proper Terms to Describe Age-Hardening. C. H. M. JENKINS. *Metal Progress*, Vol. 25, June 1934, pages 47-48. Gives definitions of terms suggested by Institute of Metals to cover processes and phenomena involved in softening and age hardening. Terms defined are annealing, tempering, solution treatment, low temperature treatment, age hardening, accelerated and artificial aging. WLC (5)

Some Experiments on the Heat-Treatment of Malleable Cast Iron. J. E. HURST. *Foundry Trade Journal*, Vol. 49, Dec. 21, 1933, pages 355-358. Deals with experiments conducted on the heat-treatment of white heart and black heart malleable cast iron. OWE (5)

Heat Treatment of Light Metals (Wärmebehandlung von Leichtmetallen). K. MERTENS. *Metallwirtschaft*, Vol. 13, May 11, 1934, pages 337-339. While the coefficient of thermal conductivity of Al and Al alloys is very high, their heat radiating properties are very low. At higher temperatures the heat transfer from the furnace to the work in still air is effected almost entirely through radiation. If heat treating furnaces with still air are used the furnace temperature must be considerably higher than the desired temperature for the work to be treated, if the work is to be heated through in a reasonable time. In order to reduce this temperature differential and gain greater accuracy and control without increasing the time of heating, furnaces with artificial air circulation should be used. Several electric furnaces, pot and muffle type, with built-in fans or blowers for air circulation, are described. CEM (5)

Annealing (5a)

Off-Peak Annealing Cuts Power Cost in Half. HERBERT R. SIMONDS. *Iron Age*, Vol. 133, June 7, 1934, pages 20-22. Describes method of storing electricity in a salt bath furnace so as to utilize relatively low cost off-peak electric energy. Method was developed by A. B. & J. Rathbone. The scheme is able to show a saving of nearly 60% in cost of power for heat treating. Advantage is taken of the gradual drop in temperature by successfully annealing different metals at lower temperatures. VSP (5a)

Improving the Quality of Furnace Products. W. G. MCDONALD. *Electric Journal*, Vol. 31, Apr. 1934, page 163. Quality control of an annealing furnace is obtained by the use of a photo electric tube, and an electric tachometer with recorder. CBJ (5a)

Bright Annealing and Normalizing in Controlled-Atmosphere Electric Furnaces. R. R. LA PELLE & C. H. CARPENTER. *Iron Age*, Vol. 132, Sept. 28, 1933, pages 28-31, 78. Describes some of the methods of bright annealing and normalizing and the possible future applications for the processes. Some of the future applications include normalizing of cold-rolled strip steel, enameling stock, deep drawing tin plate, steel wire and welded steel tubing. The process offers great advantages, both in lowered cost and in improved product. VSP (5a)

Hardening, Quenching & Drawing (5b)

Quenching and Tempering of Alloys. ALBERT PORTEVIN. *Engineer*, Vol. 155, May 12, 1933, pages 480-481; *Engineering*, Vol. 135, May 19, 1933, page 549. See "Quenching and Drawing Phenomena in Alloys," *Metals & Alloys*, Vol. 5, May 1934, page MA 185. LFM (5b)

A Modern Hardening Plant in an Automobile Factory (Eine moderne Härterei in einem Automobilwerk). E. FR. RUSS & BUCHKREMER. *Automobiltechnische Zeitschrift*, Vol. 37, May 25, 1934, pages 280-283. Layout and equipment of plant and furnaces are described; pusher furnaces of 10 m. length are used for heating and annealing of small parts. Ha (5b)

Hardness Variations as Controlled by Temper Colors. ALFRED HELLER. *Iron Age*, Vol. 133, Apr. 26, 1934, pages 24-25, 68. Gives results of investigation made concerning the reliability of drawing to color. Time element is automatically controlled when tempering to color and this is of great importance. A number of conditions affect appearance of temper colors such as amount and kind of light, eye sight of observer and speed of heating. Cr has a decided retarding influence on appearance of temper colors. High Cr % cannot be accurately drawn by color method. Main requisite in tempering by color is to heat uniformly enough to produce an even color, the one exception being the purple range where a variation in color is permissible. VSP (5b)

Surface Hardening of Steel Shafts with the Oxy-Acetylene Flame (Oberflächenhartung von Stahlwellen mittels der Azetylen-Sauerstoff-Flamme). E. KALISCH & K. SPAEH. *Autogene Metallbearbeitung*, Vol. 27, Mar. 15, 1934, pages 81-85. The high temperature of the point of the white core of the C_2H_2 flame together with its compact size make it very suitable for local hardening of steel objects. Hardening in this manner is a purely physical phenomenon (contrary to case-hardening where C or N is absorbed and cause a chemical change of structure). The area to be hardened is heated by the flame to hardening temperature and quenched by a water-jet or by immersion in water; quenching prevents the normal transformation of the solid solution and produces a very hard, martensitic structure. Steels to be hardened in this manner should have at least 0.3% C. Surface hardness and depth of hardness were investigated as function of varying amounts of gas used; a chart shows that the hardness increases linearly with increasing amount of gas up to about 575 Brinell and then increases only slowly to about 600. Depth of hardness increases practically linearly. Uniform flame, always the same amount of cooling water and correct motion of the flame are imperative for good and economical results; micrographs show structures for normal, super- and underheating. Ha (5b)

Aging (5c)

1 **Cutting Tools Research Committee: Report on the Aging of Tool Steel.** E. G. HERBERT. *Proceedings Institution of Mechanical Engineers*, Vol. 124, Apr. 1933, pages 645-683. **Improving the Quality of Tool Steel by Magnetic Treatment.** *Metallurgia*, Vol. 9, Nov. 1933, pages 11-15 (Condensed). 18 references. Gives details of a study made of the hardness changes occurring during several hours after a secondary heat treatment of high speed steels, the treatment being applied repeatedly to the same specimen. Considers the changes which take place which enable tools to be straightened by bending immediately after hardening. Periodic fluctuations have been observed during the aging of metals after severe disturbance by thermal, mechanical, or magnetic treatment. These phenomena were investigated in Ni of 99.55% purity, electrolytic Ni of 99.971% purity, electrolytic Fe of 99.96% purity, and Au of 99.995% purity. Fluctuations were attributed to periodic changes in the state of cohesion, probably electromagnetic in character. Experiments were conducted on high speed steel to find the combination of thermal and magnetic treatment which would set up fluctuations of greatest amplitude capable of being stabilized magnetically at a maximum or minimum phase so as to produce the greatest permanent change in the physical characteristics of the steel. By a suitable combination of magnetic and thermal treatments it was found possible to increase the life of a twist drill many times. Discusses the influence of the mechanism of the various hardness tests. Experiments on duralumin confirmed the results obtained with pure metals and with high speed steel. Includes many graphs. JLG+RHP (5c)

2 **Aging of Mild Steel Sheets.** R. O. GRIFFIS, REID L. KENYON & ROBERT S. BURNS. *Iron Age*, Vol. 131, June 1, 1933, pages 861-862; *Yearbook American Iron & Steel Institute*, 1933, pages 142-159, discussion pages 160-165. See *Metals & Alloys*, Vol. 5, Mar. 1934, page MA 94. VVK+VSP (5c)

Malleableizing (5d)

3 **Characteristics and Manufacture of Malleable Iron Castings.** *Commonwealth Engineer*, Vol. 21, Feb. 1, 1934, pages 201-202. Article describes the properties and methods of manufacture of malleable Fe products and gives a brief illustrated description of the works of Malleable Castings Ltd., Marrickville, N. S. W. WH (5d)

4 **Malleable Cast Iron Annealed in a Short Cycle.** A. E. WHITE & RICHARD SCHNEIDEWIND. *Metal Progress*, Vol. 25, June 1934, pages 25-29. Common malleable iron requires from 5-7 days to convert the hard white iron to a structure composed of graphite and silico-ferrite. In past few years much has been done to shorten this annealing cycle and various methods involve changes in composition and annealing treatment or both. It is stated that nuclei of graphitization form at soaking temperature due to 2 simultaneous reactions,

$$Fe_3C \longrightarrow 3\,Fe + C$$
$$2FeSi + Fe \longrightarrow Fe_3Si_2$$

and that the nuclei are not inherent but the nuclei forming capacity is inherent in the iron and nuclei result upon the application of heat. Graphitization proceeds in gamma iron until all the carbide is decomposed except that required to saturate the austenite at that temperature. Graphitization will proceed at temperatures below the critical but slowly hence commercial malleable iron is made by annealing in two stages. Si appreciably affects the solubility of carbide in gamma iron and consequently the graphitizing action above the critical is made more complete by high Si which decreases the solubility. Ni also acts favorably and Cr and Mo unfavorably. 1.5% C, 1.7% Si alloy has been malleableized in 6 hr. Such low C, high Si malleable in addition to more rapid reaction to annealing give better strengths. Tunnel or continuous furnaces can be designed to speed up the graphitization over that obtained in a batch type furnace. Excellent and interesting properties are to be obtained from partially malleableized iron consisting metallographically of ferrite and spheroidized carbide or pearlite. WLC (5d)

Carburizing (5e)

6 **Grain Size and Grain Growth.** M. A. GROSSMANN. *Metal Progress*, Vol. 24, Oct. 1933, pages 30-34. From figures given on grain size after carburizing at temperatures of 1700°, 1800°, 1900° and 2000° F. it is concluded that coarsening of the grain takes place due to the time and temperature of the carburizing treatment, in the range where such growth occurs but that the range in which such growth does not take place may in some cases extend up to 2000° F. when temperature and time are without effect. 8 steels were studied with C 0.12-0.18%, 2 Mn ranges around 0.40% and 0.80%, S and P less than 0.025% and Si 0.16-0.29%. WLC (5e)

7 **Gas Carburizing, A Discussion of Shop Practices.** H. W. MCQUAID. *Metal Progress*, Vol. 26, July 1934, pages 22-27. Describes and discusses various types of gas carburizing equipment and practices. WLC (5e)

Improved Alloy Carburizing Containers. E. F. CONE. *Iron Age*, Vol. 133, Mar. 1, 1934, pages 19,76,78. Describes a cylindrical carburizing container developed by Timken-Detroit Axle Co. in which material is packed vertically. Each piece is packed in an individual container. Speed of carburizing is increased. Rezistal No. 4 is the material used in making the containers. VSP (5e)

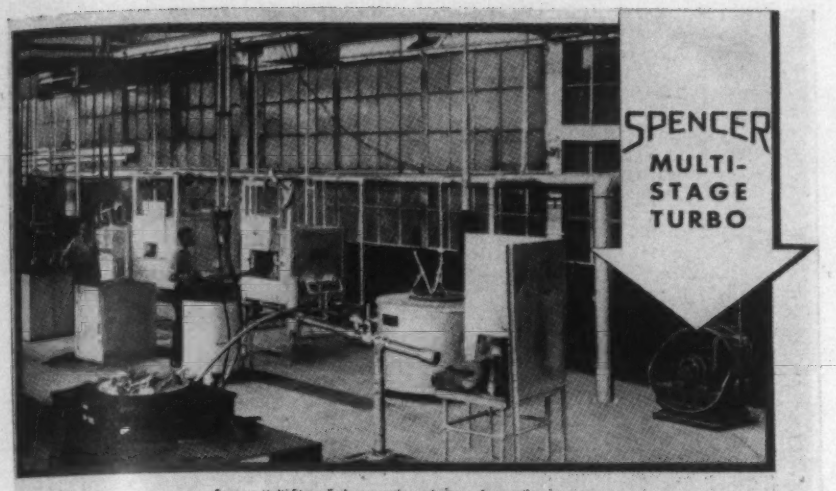
Nitriding (5f)

8 **Cast Iron Suitable for Nitrogen Hardening.** J. E. HURST. *Iron Age*, Vol. 131, May 18, 1933, pages 776-779. See "Nitricastiron. Cast Iron Suitable for Hardening by the Nitrogen-Hardening Process," *Metals & Alloys*, Vol. 4, Nov. 1933, page MA 354. VSP (5f)

Electrolytic Tinning as Protection against Nitriding (La stagnatura elettrolitica per la protezione contro la nitrurazione). A. BARATTINI. *Industria Meccanica*, Vol. 16, Feb. 1934, pages 94-95. If certain parts of a piece should retain their original properties when the whole piece is case-hardened by nitriding, it is recommended to electrolytically deposit Sn on those parts. Ha (5f)

9 **On the Nitriding of Iron and Iron Alloys IV (Ueber die Nitrierung von Eisen und Eisenlegierungen IV).** O. MEYER & W. SCHMIDT *Archiv für das Eisenhüttenwesen*, Vol. 7, May 1934, pages 647-654. The nitriding of Fe-Cr alloys was studied, Cr being next to Al, the most important alloying element in nitriding steel. During nitriding of the Fe-Cr alloys the ferrite aids diffusion by first combining with and then giving off N, which in turn is absorbed by the Cr. The slightly soluble Fe Cr N solid solution formed in the N rich surface layer precipitates out as a grain boundary network and within the grains, this causing the hardness. The nitride hardening was not accompanied by marked lattice distortion. The nitrided Fe-Cr alloys unlike the Fe-Al alloys can be repeatedly hardened by quenching and tempering. Ti in an Fe-Cr-Al alloy produced a high strength core after nitriding because of precipitation hardening. SE (5f)

10 **Cast Iron Suitable for Nitrogen Hardening. Nitricastiron** (Centrard). J. E. HURST. *Foundry Trade Journal*, Vol. 49, Nov. 2, 1933, pages 243-244, 247; Nov. 9, 1933, pages 259-261. Article accompanied by 11 illustrations and dealing with the alloy cast irons suitable for nitrogen hardening, which are manufactured and sold by Sheepbridge Stokes Centrifugal Castings Co., Ltd. As typical of compositions used in this connection the following may be mentioned: total carbon 2.65%, graphite 1.10%, combined carbon 1.55%, silicon 2.58%, manganese 0.61%, sulphur 0.07%, phosphorus 0.096%, chromium 1.69%, aluminum 1.43%. Paper deals with the properties of the material, and with the heat treatment, microstructure, machinability and methods of nitrogen hardening. Applications of this material are dealt with in considerable detail. See also *Metals & Alloys*, V. 4, Nov. 1933, page MA 354. OWE (5f)



Spencer Multi-Stage Turbo operating a battery of annealing furnaces.
Below we show also the Spencer Midget for individual unit operation, and the Spencer Single Stage Unit.

THE NAVAL AIRCRAFT USES SPENCER

HEATING and annealing aircraft parts is a serious business. It requires a safe, steady and dependable air supply.

For this kind of service the Naval Aircraft Division at Philadelphia uses Spencer Turbo to supply air to the battery of furnaces shown above.

The Single Stage Spencer Turbo uses less space, costs less and is recommended for most services within its range: ¼ to 16 oz., ½ to 20 H. P. For heavy duty service and larger sizes, the well known Spencer Multi-Stage Units are available.

Ask your furnace or oven manufacturer for the Spencer Bulletins.

SPENCER
TURBO-COMPRESSORS

THE SPENCER TURBINE CO. · · · HARTFORD, CONN.

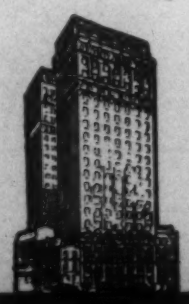
The Ideal LOCATION in PHILADELPHIA

Everything worthwhile in Philadelphia is at your very doorstep when you stop at Hotel Adelphia. Every point of historic interest ..stores...theatres...are easily reached. Here at this fine hotel you can enjoy every comfort and every luxury at low cost.

400 ROOMS

from $3.50 single from $5 double

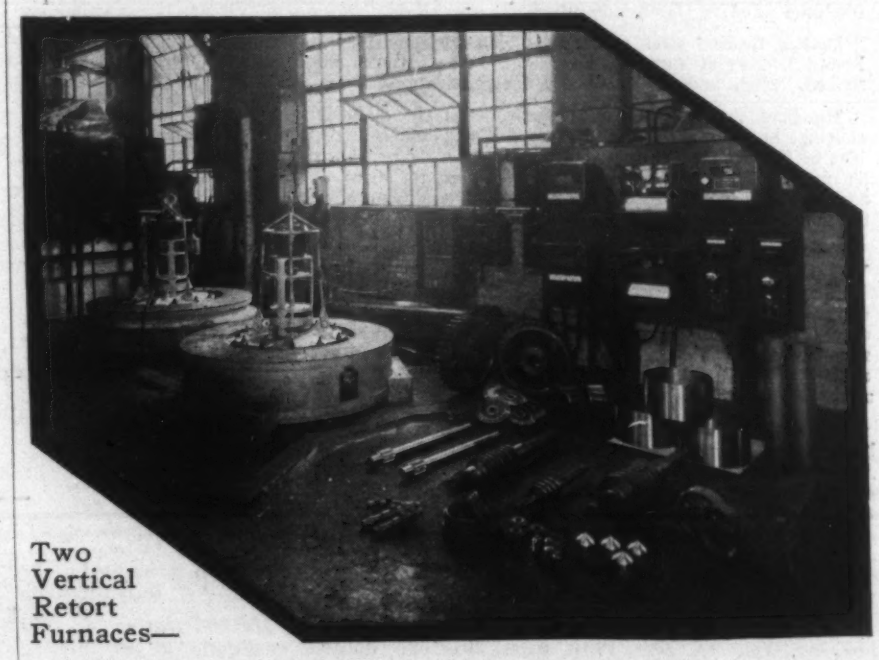
ADELPHIA HOTEL COMPANY
DAVID B. PROVAN *Managing Director*



HOTEL
ADELPHIA
CHESTNUT AT 13TH STREET

ELECTRIC FURNACES

GOING TO THE SHOW?



Two Vertical Retort Furnaces—

Let Representatives At Booth No. 411 Tell You About The

FLEXIBLE FURNACE

Hevi-Duty Vertical Retort Furnaces which are readily interchangeable to such heat treating processes as *Carburizing, Nitriding, Annealing, Drawing,* etc., are in daily operation in many plants throughout the country .... The adaptation of this furnace to the many different heat treating processes has resulted in GREATER PRODUCTION FROM ONE INVESTMENT .... And these performances have proved that quality products are made with surprising economy .... Our Representatives at Booth No. 411 can give you some startling facts about these furnaces—Your failure to make inquiry is your Company's loss!

TRADE MARK
HEVI DUTY
REG. U. S. PAT. OFF.

HEAT TREATING FURNACES

ELECTRIC EXCLUSIVELY

HEVI DUTY ELECTRIC CO.

MILWAUKEE, WIS.

FURNACES, REFRACTORIES & FUELS (6)

M. H. MAWHINNEY, SECTION EDITOR

Electric Furnaces (Elektrische Schmelzöfen). RUDOLF TAUSSIG. Julius Springer Verlag, Vienna, 1933. Paper 7¾x10¾ inches, 241 pages. Price 39 RM.
Abandoning the usual German custom, Taussig pays no attention to patent literature, and does not fill his pages with suggestions that never worked out in practice, but confines himself to a description of electric smelting and melting furnaces in actual use, chiefly those in Germany.

The introduction discusses thermochemical calculations, slags, calculation of charges, furnace efficiency, practical ways of decreasing heat losses, electrical calculations and circuits, and then turns to a description of transformers for heavy currents which is profusely illustrated. Conductors, inductive effects, the skin effect and transformer connections are then dealt with.

Furnace construction and lining, electrodes, electrode joints, Soderberg and Mignet electrodes, electrode holders, carriers and contacts, means for adjustment, etc. are described in detail. The illustrations are particularly interesting; for example, one showing 3 Soderberg electrodes 50 in. diameter for a 15,000 k.w. carbide furnace; another, the details of a hydraulic adjustable holder for a 36" electrode. Automatic electrode controls are also discussed in some detail. Refractories are but briefly discussed.

Modern German steel melting furnaces are illustrated, quite detailed drawings of Fe-Mn and Fe-Si furnaces are shown, and a Mignet iron smelting furnace is described. High and low frequency induction furnaces are also dealt with.

The book does not take up in any detail the metallurgy of electric smelting or melting, but sticks closely to furnace design and construction. It gives a very good idea of the detailed engineering being put on modern German furnaces. It is printed on paper that allows the fine illustrations to show to best advantage, and is adequately indexed. Those dealing with the design of large furnaces will find it most interesting. H. W. Gillett (6)-B-

Refined Fuels, So-Called, for Heat Treating. ROBERT M. KEENEY. *Iron Age*, Vol. 131, May 25, 1933, pages 827-828. Abstract of paper read before the Hartford chapter of the American Society for Steel Treating. Selection of source of heat for heat treatment is an economic problem of overall costs, and B. T. U. is only part of overall cost. Sources of heat of highest form value are: Electricity, manufactured or natural gas, butane and oil. Electricity and manufactured gas are termed refined fuels. Deals with the importance of the refined fuels in control of atmospheres in furnaces. VSP (6)

Application of the Söderberg Electrode in Modern Ferro Alloy Furnaces (Söderbergselektrodens användning vid moderna ferrolegeringsungnar) C. VON DELWEIG. *Jernkontorets Annaler*, Vol. 117, Feb. 1934, pages 81-93. The advantages of the Söderberg electrode are the following: (a) the electrode cost can be reduced to 40%-75%, (b) the electrode losses are only 50%-80% of the losses for total electrodes, (c) the production of the furnace is increased because of fewer shutdowns and smaller heat losses, (d) the current density can be raised to 14 amps. per sq. cm. as against 4-6 amp. for other types, (e) less supervision is required, and (f) any size or shape of the electrode can be prepared. HCD (6)

Laboratory Tube Furnaces. FRANCIS A. WESTBROOK. *Heat Treating & Forging*, Vol. 20, June 1934, pages 301-302. Outlines experiences in use of tube type of industrial laboratory furnace for determining C in alloy steels; high temperature work; and heat treating at temperatures above 1000° C. MS (6)

1 **Ratio of H_2 to CO in Products of Combustion.** JEROME J. MORGAN & CHARLES STOLZENBACH. *Gas Age-Record*, Vol. 73, Mar. 31, 1934, pages 301-304. Abstract of M. S. thesis, Dept. of Chemical Engineering, Columbia University, by Charles Stolzenbach. Experimental evidence has been given that, when carbonaceous fuels containing sufficient hydrogen are burned under conditions such that the free hydrogen in the products of incomplete combustion does not exceed 3%, the ratio of the volume of carbon monoxide to the volume of hydrogen in these products of incomplete combustion is a constant having a value of 2.9. A plausible explanation of this constant ratio is that the water gas reaction controls the ratio between carbon monoxide and hydrogen in the combustion products. The value, 2.9, is also indicated as the ratio between the volumes of carbon monoxide and hydrogen in the analysis of the combustion gases from bituminous coal reported by Kreisinger, Augustine and Ovitz of the U. S. Bureau of Mines. These results, therefore, appear to contradict the statement occurring repeatedly in the literature of combustion, that when hydrogen and carbon monoxide burn simultaneously the hydrogen burns 2.86 times as fast as the carbon monoxide. VVK (6)

2 **Development and Present Status of Hot Blast Apparatus (Évolution et état actuel des Appareils à Vent Chaud).** A. GRAFF, J. PAQUET & M. STEFFES. *Revue Technique Luxembourgeoise*, Vol. 26, Mar./Apr. 1934, pages 25-32. Principles and advantages of using preheated air in the blast-furnace, apparatus and constructive details, operating data of recuperators and possible future developments are discussed. 20 references. Ha (6)

3 **Natural Gas Furnaces In Steel Tube Making.** J. B. NEALEY. *Iron Age*, Vol. 132, Nov. 23, 1933, pages 18-19, 51. Describes furnaces used at the Ellwood plant of the National Tube Co. There are more than 25 furnaces, all fired with natural gas, including heaters, reheaters, pointing furnaces, annealers, etc. Most of the large heating furnaces are of the same type and design and all are equipped with luminous flame burners. VSP (6)

4 **The Electric Melting and Heat Treatment of Iron and Steel.** A. G. ROBIETTE. *Foundry Trade Journal*, Vol. 50, Feb. 22, 1934, pages 132, 139. *Heat Treating Furnaces. Heat Treating & Forging*, Vol. 20, Feb. 1934, pages 91-93; Mar. 1934, pages 147-148. *Construction and Use of Electric Heat-Treatment Furnaces. Sheet Metal Industries*, Vol. 8, Mar. 1934, pages 155-157. Extract from a paper read before the West Scotland Iron and Steel Institute at Glasgow. Discusses self-regulating induction furnaces, resistor-heated furnaces, batch and continuous type furnaces, and the use of forced air circulation and protective atmospheres. OWE+AWM+MS (6)

5 **The Development of Gas as an Industrial Fuel.** JOSEPH E. WHITE. *Institution of Gas Engineers*, Communication No. 72, 1933, 46 pages. *See Metals & Alloys*, Vol. 5, Jan. 1934, page MA 28. AHE (6)

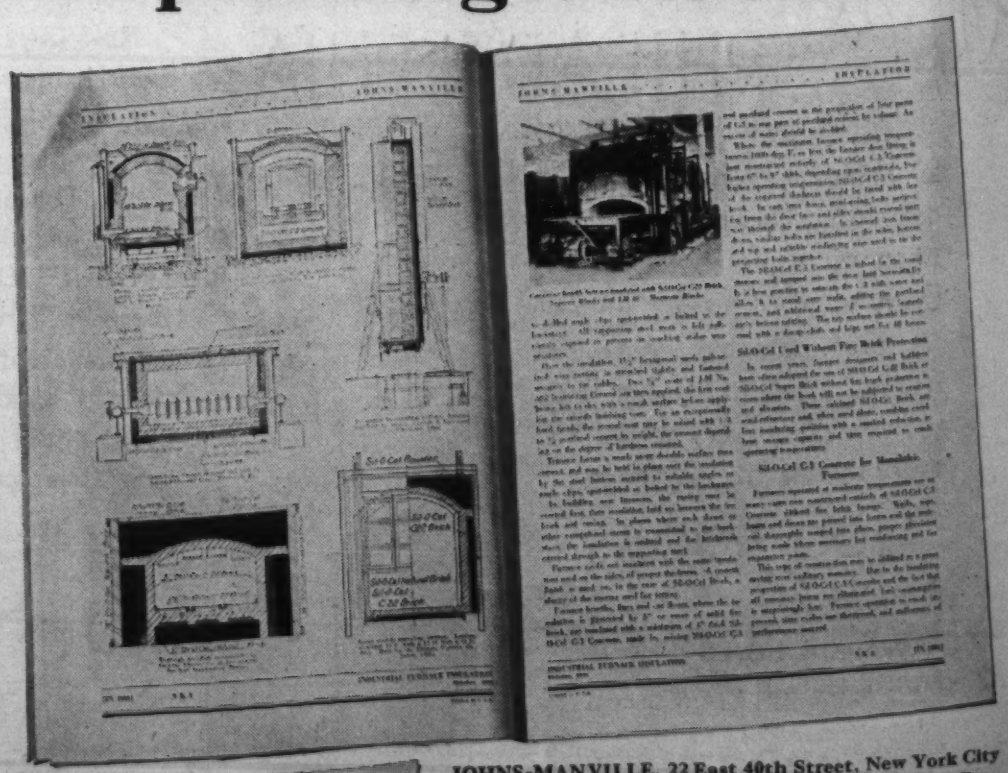
Vacuum Furnaces in Metallurgy. N. A. ZIEGLER. *Metals & Alloys*, Vol. 5, Jan. 1934, pages 5-9. Some of the reactions taking place between metals and the gases surrounding them at high temperatures, either in annealing (solid metal) or melting are set down and the effect of vacuum upon their equilibrium discussed. The construction of silica or other tube furnaces heated by resistances or by induction are described. The vacuum being maintained within the tube and the heating applied externally to the tube. The bell jar type vacuum induction furnace is described with the difficulties encountered in bringing the electrical and water cooling connections through the vacuum seal. Induction heating cannot be satisfactorily controlled as to temperature which limits this method to melting. Vacuum melting of such alloys as 4% Si-Fe, 8% Al-Fe, and pure Cu are being practiced on a commercial scale in Europe in increasing amounts. As the improvement in their properties can be shown to outweigh the added cost this type of production will increase. WLC (6)

Correct Insulation sends Furnace Production up...Operating Costs down

Send for this Johns-Manville treatise on the Control of Heat Losses

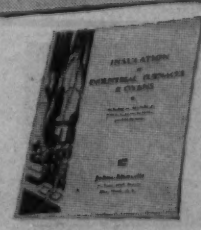
ITS recommendations are based on Johns-Manville's 76 years of research and experience. Its data cover not only the insulating of heat-treating furnaces, but blast-furnace and open-hearth systems, boilers, piping and other high-temperature equipment.

Interesting text describes the heat control methods that have proved most effective in improving performance and reducing operating costs in your particular field. Actual photographs, scores of drawings, picture the correct application of the complete line of J-M Industrial Insulating Materials. Let us send you a copy *free*. Mail the coupon. Johns-Manville, 22 E. 40th St., New York City.



Johns-Manville
INDUSTRIAL INSULATIONS
For every temperature condition from 400° F. below zero to 3000° F. above

FREE—MAIL THE COUPON



JOHNS-MANVILLE, 22 East 40th Street, New York City
Send me a free copy of "Insulation of Industrial Furnaces & Ovens."

Name_____ Title_____
Firm Name_____
Address_____
City_____ State_____ MA-10-34

ALUNDUM REFRACTORIES

CRYSTOLON REFRACTORIES

MAGNESIA REFRACTORIES

For Enameling Metal

WHETHER you are enameling cast iron or steel—in box furnaces or continuous furnaces—you'll find that Alundum Refractories (fused alumina) have just the right characteristics:

Resistance to high temperatures
Great strength
High heat transfer
Stability
Long life
Low fuel cost

For Heat Treating Metal

IN many types of heat treating furnaces you'll find Crystolon Refractories (silicon carbide) meeting exacting requirements. They are popular because of these features:

Resistance to high temperatures
Great strength
High heat transfer
Resistance to spalling
Resistance to abrasion
Long life
Low fuel cost

For Melting Metal

IN all types of induction furnaces—large and small—for melting ferrous and non-ferrous metals—Norton electrically fused magnesia refractories are widely used. Available in the form of cements and bonded shapes—in different mixtures to meet different conditions. Their features:

Resistance to high temperatures
Chemical resistance and low permeabilities to molten metals and oxides

NORTON COMPANY, Worcester, Mass.

NORTON

NORTON REFRACTORIES

R-491

Speed Up Production

with TAYLOR REFRACTORY INSULATING BRICK!

SAVE UP TO 78% in time and up to 70% in fuel required to reach operating temperature in your periodic heat-treating or annealing furnace.

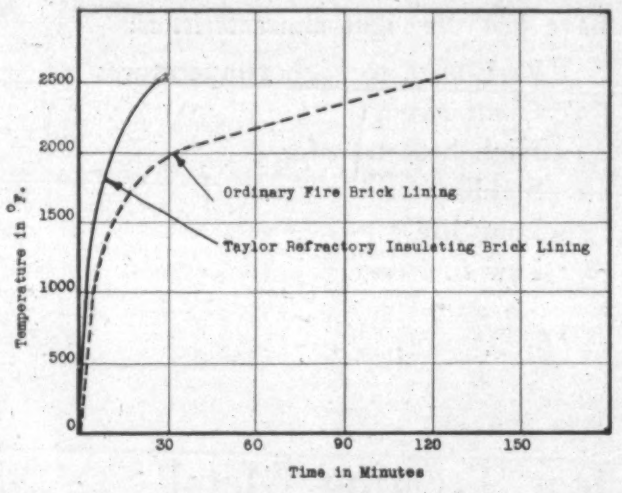


Chart drawn from data obtained on two gas-fire heat-treating furnaces identical except for type of linings.

Send for our booklet describing
TAYLOR REFRACTORY INSULATING BRICK.

THE CHARLES TAYLOR SONS CO.
CINCINNATI, OHIO
Manufacturers of P. B. Sillimanite,
Fire Clay and High Alumina Refractories.

Reduce Refractory maintenance with

J-M HELLITE

Ready mixed for
BRICK SETTING . . .
WASH-COATING . . .
and HOT-PATCHING

Recommended for
Temperatures up to 3000° F.

Write for BROCHURE-RC-6A

Johns-Manville
22 East 40th Street, New York City

. **Controlled Atmospheres for Electric Furnaces.** H. M. WEBBER. *Iron Age*, Vol. 133, Mar. 29, 1934, pages 20-23. After brief discussion of the development of controlled atmosphere furnaces, gives present day uses in bell type, continuous, and batch type furnaces. Gives analysis of industrial and processed gases used for controlled atmospheres. VSP (6)

1 **Insulating the Open-Hearth Furnace.** H. J. WILLIAMS. *Iron Age*, Vol. 132, Sept. 28, 1933, pages 36-37, 80. Discusses the advantages of insulating of open-hearth furnaces. For insulation to save on heat losses and prevent infiltration of air, author recommends 4 in. of mineral wool for roofs and 1½ to 2 in. of cement comprising slag wool mixed with water glass for all other exposed brick work, including the regenerating chambers. Complete insulation of natural gas fired open-hearth furnaces should result in the following advantages: (1) Reduced heat loss from walls and roof; (2) increased life of brick work; (3) increased radiation from roof to bath; (4) reduced infiltration of cold air; (5) increased temperatures of preheat; and (6) improved working conditions. VSP (6)

2 **Regenerator Chambers for Furnaces Using Natural Gas.** H. J. WILLIAMS. *Iron Age*, Vol. 132, Sept. 14, 1933, pages 20-22. Regenerators on open-hearth furnace preheat the air for combustion. Factors affecting temperature of preheat are: (1) Temperature of products of combustion; (2) Design of regenerative chambers and checker work; (3) Amount of air preheated. Emphasizes importance of minimizing air infiltration by use of steel jacketing. Treats mainly of the method of calculating sizes of regenerators for natural gas fired open-hearth furnaces. VSP (6)

A Precision Couple for Measuring Gas Temperatures. E. O. MATTOCKS. *Metal Progress*, Vol. 26, July 1934, pages 37-40. Describes special quartz protection tube in which the hot gases are drawn by suction rapidly over the bead of the thermocouple to obtain a true gas temperature. WLC (6)

3 **Open-Hearth Furnaces With Natural Gas Firing.** H. J. WILLIAMS. *Iron Age*, Vol. 132, Aug. 31, 1933. pages 11-13. Discusses the advantages of using natural gas in open-hearth furnaces. The advantages claimed are: (1) Reduction of construction costs; (2) Reduction of maintenance costs; (3) Improvement of combustion; and (4) Improvement of quality of steel. VSP (6)

Modern Cupola Practice. H. H. SHEPHERD. *Foundry Trade Journal*, Vol. 50, Feb. 8, 1934, pages 99-101. A discussion of the balanced-blast cupola and its application in malleable foundry practice. Attention is directed to design, to lining of the cupola, and to a variety of important factors connected with operation of the equipment. OWE (6)

4 **Natural Cooling and Heat Recovery (Natürliche Abkühlung und Warmerückgewinnung).** K. MERTENS. *Elektrowärme*, Vol. 4, June 1934, pages 132-136. Several examples are given to show that in spite of high cost of electric energy the economy of electric furnaces for metallurgical and ceramic purposes can be improved largely by recuperation of heat so that they can easily compete with fuel-fired furnaces. Ha (6)

Heating Equipment of the New-Moscow Tin Plate Works. A. VITKIN. *Domez* No. 11-12, 1933, pages 1-32. In Russian. Considerations used as a basis for the design of the heating equipment of a plant intended for a production of 5,000,000 base boxes of tin plate per annum. Nothing is built as yet. (6)

5 **New Developments in Electric Bright-Annealing Furnaces.** TAMÉLE. *Iron & Coal Trades Review*, Vol. 128, May 4, 1934, pages 726-727; May 11, 1934, pages 758-759. *See Metals & Alloys*, Vol. 5, June 1934, page MA 262. Ha (6)

Electric Furnaces. E. MORGAN. *Electrical Review*, Vol. 114, June 1, 1934, pages 792-793. Use of electric furnaces for steel melting is increasing rapidly. In 1933, Sheffield, Eng., district produced 55,000 tons of electric steel compared with 39,000 tons in 1932. Sheffield Corporation Electricity Department has a furnace load of 28,000 kw. connected to its system with orders for connecting an additional 22,000kw. Outlines principal characteristics of arc and high-frequency melting furnaces and pays brief attention to heat-treating furnaces. MS (6)

6 **Insulating Open-Hearth Furnaces.** W. M. HENRY & A. W. SMITH. *Iron Age*, Vol. 131, June 1, 1933, page 875. Abstract of discussion of paper read before the American Iron & Steel Institute, May 25, 1933. See "Insulation of Open Hearth Furnaces," *Metals & Alloys*, Vol. 5, Apr. 1934, page MA 137. VSP (6)

Economic High Temperature Furnace for 3000° C. abs. max. (Ein Hohlraumstrahler (Wolframofen) geringen Energiebedarfs für Temperaturen bis 3000° C. abs.) CARL MÜLLER. *Forschungen & Fortschritte*, Vol. 9, Feb. 20, 1934, page 83. Describes and illustrates an induction furnace developed by the cooperating Physikalisch-Technische Reichsanstalt, Siemens Co., and Osram Co. In a few minutes a temperature up to 3000° abs. can be attained on a power consumption of only 8-10 kw. The principal furnace materials are Mo foil, ZrO_2, ThO_2, and quartz which are ingeniously arranged to prevent cracking due to the extreme temperature changes. Low pressure N_2 atmospheres are employed. W metal could be intensively volatilized in the "semi-vacuum" and the melting of high melting materials, for instance of Mo (2600°C.) can be advantageously carried out. EF (6)

7

Ports of Open-Hearth Furnaces Fired with Natural Gas. H. J. WILLIAMS. *Iron Age*, Vol. 132, Sept. 7, 1933, pages 14-17. Ports on open-hearth furnace serve alternately as an inlet for fuel and air and as an outlet for products of combustion. Port design generously recommended consists of a single uptake for preheated air and a single port for the gas-air mixture. It is generally successful for natural gas firing. Slope of port must be sufficient to drop the flame low enough to sinter bottom of furnace. Port design recommended by author has a slope of port roof of 4 in. per ft. and slope of port floor of 1½ in. per ft. Gives method of entraining gas. Construction of suitable port is first step toward successful operation of natural gas fired open-hearth furnace. VSP (6)

8

Ford Uses Many Types of Furnaces in Forging Plant. J. B. NEALEY. *Steel*, Vol. 94, Apr. 23, 1934, pages 25-27. Describes gas-fired furnaces in the Rouge plant of the Ford Motor Co. These include slot-type forging furnaces, continuous furnaces of the chain and sprocket type for forging and normalizing; pusher-type normalizing furnaces; car-type and stationary-hearth billet furnaces; and various special types. Bed of 2-2½ in. of powdered dolomite protects hearths of forging furnaces. MS (6)

9 **Utilization of Coke Oven Gas.** M. KOOPMAN. *Iron & Coal Trades Review*, Vol. 128, May 11, 1934, pages 760-761. May 18, 1934, page 806. With discussion. The paper read before the Institute of Fuels discussed development of coke-oven gas distribution in Europe and economies possible by its use in steel plants. A few plants with transmission pipe lines are described. Ha (6)

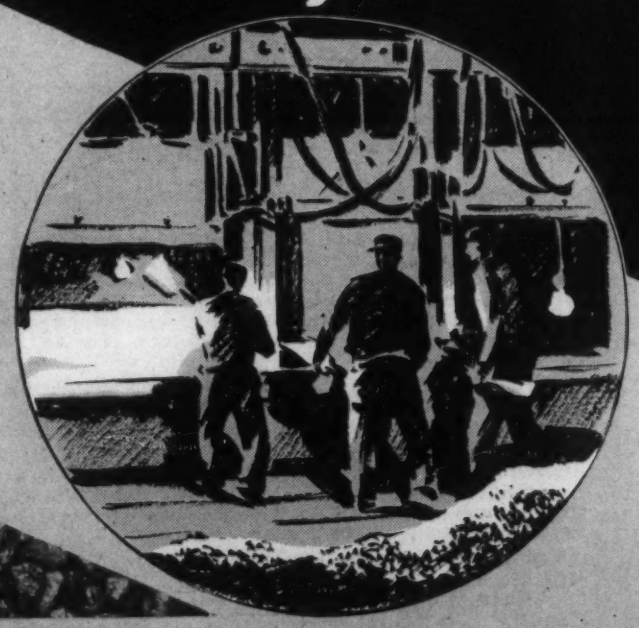
Testing of Metallurgical Furnaces and Metallurgical Control. C. T. EDDY & J. R. MARCOTTE. *Bulletin Michigan College of Mining & Technology*, Vol. 7, Oct. 1933. Paper, 6x9 in., 32 pages. Paper prepared for Lake Superior Mining Institute "as results of questions and discussions arising in connection with the use of thermal and material balances" in study of operation of reverberatory furnaces, and hence devoted primarily to discussion of several methods of collecting data. Gives factors influencing adaptability of such data to desired studies and discusses accuracy of observations. Deals briefly with subject of combustion control. Presents one specific example of a material and energy balance for a complete operating cycle of a 120,000-lb. reverberatory Cu smelting and refining furnace and calculates the various efficiencies discussed. MFB (6)

10

Tar-Sealed MAGNEFER LASTS Longer!

PATENT PENDING

PATENTED



"OIL AND WATER DO NOT MIX"

These beakers contain equal amounts of uncoated *{left} and* Tar-sealed *Magnefer {right}. Equal amounts of water were poured from above. Approximately 1½ times as much water drained through the Tar-sealed clinker. It is evident that Tar-sealed Magnefer will absorb less moisture than an uncoated product and consequently will "stand up" longer.*

THE TAR-SEALING PROCESS, originated by Basic Dolomite, Incorporated, protects each grain of Magnefer from the disintegrating effects of air and moisture. *Oil and water do not mix* . . a familiar fact which is aptly illustrated at the left. Observe how freely the water was shed by the coating of the tar-sealed clinker. Steel refiners seem to agree that Tar-sealed Magnefer withstands slaking longer than an uncoated product and sets a new standard of usable life in the field of clinkered dolomite . . . There is no additional cost to the consumer.

BASIC DOLOMITE, INCORPORATED

HANNA BUILDING , , CLEVELAND, OHIO

MAGNEFER SETS FAST • STAYS FAST

Developments in Chemical Apparatus. Electric Furnaces, Part I. (Fortschritte des Chemischen Apparatewesens—Part I. Elektrische Oefen.) ADOLF BRÄUER & JOSEF REITSTÖTTER. Akademische Verlagsgesellschaft, Leipzig, 1934. Paper, 7¾ x 11¼ inches, 176 pages. Price 28RM.

This is the first part of a 6 part, 900 page list of German patents on electric furnaces, classified as to type, in chronological order. This part covers arc furnaces, electrodes, controls, etc., resistance furnaces, and induction furnaces with closed rings, leaving high frequency furnaces for the next, and later parts together with all kinds of mechanical devices for electric furnaces and the applications of electric heating.

The section on German patents abstracts the specification, and gives some of the claims of patents from 1882 to March 1911 (up to no. 231807) later ones to follow. The section on American patents gives the patent numbers under the U. S. Patent Office classifications, up to May 1932 but gives no abstracts.

There are a few references to technical literature, and now and then a comment as to the commercial utilization or importance of a furnace covered by a given patent. In general, the treatment is from the patent, not the technical point of view. The patented ideas are given, whether they worked or not. The book is the sort of thing a patent office would use to find prior patents to cite against an application, and it would be a great convenience to any one seeking a German patent on electric furnaces. Since foreign patents may be cited against American applications, it will be helpful to American inventors and patent attorneys in showing the state of the German art. It is not much help as to the American art, the section on arc furnaces listing by numbers over 200 U. S. Patents without further subdivision to narrow down those that should be consulted in a search. H. W. Gillett (6)—B—

The Foundry Equipment Industry in 1933. R. H. BRACKENBURY. *Foundry Trade Journal*, Vol. 50, Jan. 18, 1934, page 38. Brief article in which a partial list of British mechanized foundries is included. Reference is made to a new type of rotary oil-fired furnace (probably Stein) which has entered the field in Great Britain in 1933. OWE (6)

Use of Gas in a Pittsburgh Bolt and Nut Plant. *Iron Age*, Vol. 133, Mar. 29, 1934, pages 32-34. Gives detailed information on the use of gas for fuel in North side plant of Pittsburgh Screw and Bolt Co. VSP (6)

Recent Economies in the Use of Fuels in the Iron and Steel Industry. MARTIN J. CONWAY. *Iron Age*, Vol. 133, Feb. 15, 1934, pages 12-16. Describes method used to secure greater fuel economy in the steel and metal working industries. Includes a table showing the use of various instruments, their purpose and range. VSP (6)

The Present Position of the Oil-Fired Rotary Furnace in England. VINCENT C. FAULKNER. *Foundry Trade Journal*, Vol. 49, Oct. 26, 1933, pages 231-233. Article accompanied by 5 diagrams, dealing with experiences with 4 rotary oil-fired furnaces of the Stein design. It is noted that there are now 28 Stein furnaces in operation throughout the world. OWE (6)

Tests for Air Furnace Bung Brick Are Developed. *Steel*, Vol. 94, June 18, 1934, pages 36, 46. As a service test for comparing 2 types of brick, General Refractories Co., recommends building a frame having alternate panels, across the furnace, of the 2 brands. Panels should be 5 courses in width. MS (6)

Induction Furnaces in Sheffield. D. F. CAMPBELL. *Metal Progress*, Vol. 26, July 1934, pages 45-46. Comments upon the speed and economy of induction furnaces. WLC (6)

Protective-Atmosphere Electric Furnace Used for Brazing. *Iron Age*, Vol. 133, May 24, 1934, page 27. Describes box-type furnace with automatic temperature control and gas processing equipment installed in General Electric Service Shop, Cleveland. Furnace holds one tray load of parts in heating chamber and 2 tray loads in adjacent water-jacketed cooling chamber. Can heat 80 lb. gross per hr. Charging cycle is approximately 5 trays per hr. depending on weight of parts. VSP (6)

The Crucible Process and Metallurgical Developments. *Foundry Trade Journal*, Vol. 49, Oct. 12, 1933, pages 205-206. An article, accompanied by 4 photographs, describing the plant of the Morgan Crucible Company, Ltd. OWE (6)

Calculation of the Pressure Loss in Pipe Lines and Mains (Die Berechnung des Druckverlustes in Rohrleitungen und Kanälen). W. BARTH. *Archiv für das Eisenhüttenwesen*, Vol. 7, May 1934, pages 599-605. Calculations of the pressure losses in fluid or gas lines are made by means of a single formula which takes into account all the possible variables. SE (6)

High-Frequency Electric Furnaces. *Engineer*, Vol. 157, Apr. 20, 1934, pages 400-401. Description of two furnaces of 2 and 5 ton capacity recently installed in the Samuel Fox and Co., Ltd., works of the United Steel Co., Ltd. by the Electric Furnace Co., of London. These are the largest and most modern furnaces operated in Great Britain. Diagrams are given showing the lay-out and the circuit for the two furnaces. LFM (6)

Refractories in 1933. T. ALLEN. *Foundry Trade Journal*, Vol. 50, Jan. 18, 1934, page 40. General. OWE (6)

Electric Furnaces in USSR (Les fours électriques en USSR). L. ARONOV. *Journal du Four Electrique*, Vol. 43, May 1934, pages 166-170; June 1934, pages 203-207; *Domez*, 1934, No. 2-3, pages 1-14 (In Russian). The total number of electric furnaces for melting metals installed is 267 with a total KWH consumption of 310,000. No new designs were developed. Most of the furnaces belong to well known types. The maximum capacity of steel melting furnaces is 10 tons. One Miguet-Perron furnace of 11,000 KWH is working on 45% Fe-Si and some with the capacity of 7,500 KWH are melting Fe-Mn. 153 furnaces with the total capacity of 64.6 tons are used for copper and non ferrous alloys melting. Plans for future development are given. JDG (6)

Developments in Foundry Refractories. E. J. CRAWLEY. *Foundry Trade Journal*, Vol. 50, Jan. 25, 1934, pages 71-72, 77. Article accompanied by 5 diagrams and discussing (1) cupola linings, (2) the linings of crucible furnaces, and (3) molding sands. OWE (6)

A Coke-fired Reheating Furnace. F. LLOYD & R. V. WHEELER. *Heat Treating & Forging*, Vol. 20, Jan. 1934, pages 41-44; *Engineering*, Vol. 136, Oct. 27, 1933, pages 479-480; *Sheet Metal Industries*, Vol. 7, Oct. 1933, pages 333-336. See *Metals & Alloys*, Vol. 5, May 1934, page MA 192. MS+LFM+AWM (6)

An Open Hearth Furnace for Remelting Aluminum (Ein Flammofen zum Einschmelzen von Aluminium). GOTTHARD E. LENK. *Metall und Erz*, Vol. 31, Mar. 1934, pages 103-105. The construction of a 6½ ton open hearth furnace used especially for remelting large Al alloy scrap castings is described. The furnace is oil fired and the oil consumption is low. It is not necessary to break up the castings before charging. The melting process is described. Melting loss is kept down to .8% of the metal charged. CEM (6)

High Frequency Induction Furnaces. W. S. GIFFORD. *Metal Industry*, London, Vol. 44, Apr. 20, 1934, pages 411-414. A brief history is outlined of the development of the high-frequency, or coreless induction furnace. The advantages of this type of melting was limited for a time to very small heats but eventually crucibles were designed that would withstand the sharp temperature gradient between the heated interior and the water-cooled exterior. This made it possible to operate furnaces with larger capacities. The process of forming the crucible inside the coils, invented by Rohn is discussed. Various improvements that have been made in the construction of the furnace and its electrical equipment are described. Several of the 2- and 5-ton furnaces installed by the Electric Furnace Co., Ltd., are described. HBG (6)

JOINING (7)

1 **Connections for Iron and Steel Cables (Attaches et Jonctions pour Cables Metalliques en Fer et en Acier)** BIGOURET. *Arts-et-Métiers*, Vol. 85, July 1933, pages 247-249. The article comprises a large table giving sketches of 36 kinds of joining devices: splices, jaws, buckles, etc. and the accompanying text indicates loss coefficient of strength for each kind of connection. FR (7)

— **New Austrian Welding-rods and Solders (Neue österreichische Schweissdrähte und Lote).** JOHANN TITSCHER. *Der Autogen Schweisser*, Vol. 7, Mar. 1934, pages 25-28; Apr. 1934, pages 46-50. Critical review of characteristics and application of welding rods and solders for ferrous and non-ferrous metals and alloys produced in Austria. Kz (7)

Soldering & Brazing (7a)

C. H. CHATFIELD, SECTION EDITOR

2 **Heat Economy in Soldering.** *Engineering Progress*, Vol. 14, Apr. 1933, page 70. Abstract of a report by H. Voigt & H. Wertheim in *Archiv für Wärmewirtschaft*, Nov. 1932, page 294. See "Heat Consumption in Soldering Sheets," *Metals & Alloys*, Vol. 4, Aug. 1933, page MA 237. RHP (7a)

— **Fabricating Products by Electric Furnace Brazing.** H. M. WEBBER. *Machinery*, N. Y., Vol. 39, Apr. 1933, pages 520-524. Describes a method developed by the General Electric Co. Method consists of passing assembled parts through an electric furnace, having a controlled reducing atmosphere. Cu is applied near all the joints of the parts so that when it melts it will run into the joints and form strong, tight bonds when cool. The reducing atmosphere takes the place of the flux and has the advantage of keeping the parts clean and free from oxidation.
3 Discusses design, manufacture, and assembly of parts for electric refrigerators. A photomicrograph shows the tendency toward grain growth across the joint. Cu penetrates the steel along the grain boundaries and goes into solution with the steel at the surface. RHP (7a)

— **New Developments Lower Cost of Continuous-Furnace Brazing.** C. L. WEST. *Iron Age*, Vol. 132, July 27, 1933, pages 15-16, 66. Discusses recent development of a low cost reducing gas together with necessary equipment by the Electric Furnace Co., Salem, O. Joining of steel products by brazing is accomplished in electric furnace with controlled reducing gas atmosphere at temperatures ranging from 1400° F. to 2100° F. Brazing materials used include Ag solders, brass alloys and Cu. Brass wire and powder are used where strong bond is needed.
4 Includes data on different brazing materials, on fitting and preparation of parts to be joined as well as operation and scope of furnace brazing. VSP (7a)

Welding & Cutting (7b)

C. A. McCUNE, SECTION EDITOR.

— **Electrically Welded Tanker "Rügen" (Das elektrisch geschweisste Tankschiff "Rügen")** G. WAHL. *Schiffbau, Schiffahrt und Hafenbau*, Vol. 34, Nov. 21, 1933, pages 394-396. The advance of welding in shipbuilding is traced discussing 4 sister ships built during the past 4 years. Practical experience, alterations and structural features are fully dealt with and illustrated. The weight savings in comparison with a riveted ship of the same dimensions was 36.4%
5 and has been furthermore reduced to 32.6% on the last tanker. WH (7b)

— **Disturbances in the Operation of Acetylene Generators and How to Overcome Them (Störungen beim Betrieb von Azetylenapparaten und ihre Beseitigung)** GOTTFRIED LOTTNER. Carl Marhold Verlag, Halle (Saale), 1934. Paper, 4¾x7 inches, 63 pages. Price 1.70 RM. This booklet is for the most part an outline of safety and operating precautions for acetylene generators and means of overcoming functional derangements and defects of the same. Unfortunately, the book is too much in the nature of an outline. If it had been sufficiently complete to have included a critical comparison of the various types of generators presented, which are very briefly described in the text, in the light of their susceptibility to derangement or the possible hazards involved in their operation, it would have been very valuable. As it
6 is, the text and illustrations present little more than (1) a sketchy outline of the principal operating precautions to be found in the operating instructions furnished with every generator and (2) common sense remedies for the more frequent troubles. There are numerous line-cut drawings and very brief descriptions of representative generator types, which are inadequate for any one not familiar with this art. In the case of those types which are virtually unknown in America, the information contained in the cuts and descriptions is so inadequate as to be almost or quite valueless for American readers.

Nevertheless, even in the very vague outline form in which they are presented, one or two facts of interest are revealed. One of these is that in Germany considerable emphasis is placed upon certain types, particularly the water-to-carbide type, which in comparable sizes are practically unknown in this country. Apparently
7 no such scruples are entertained in Germany. Another point of interest is that in Germany the diversity of designs is much greater than it is here. The profusion of commercial generators described in this book is rather bewildering to one who is familiar only with present day practice in America. Apropos of the difference between German and American practice is the fact (not revealed by this publication) that in Germany acetylene operating pressures as high as 22 lbs./in.^{2} are quite frequently encountered whereas American manufacturers through such regulatory bodies as the National Board of Fire Underwriters have prohibited pressures in excess of 15 lbs./in.^{2} George M. Deming (7b)-B-

8 **Contraction Stresses in Electric-Arc Butt Welds (Schrumpfspannungen bei elektrisch geschweissten Stumpfnähten)** E. H. SCHULZ & W. PÜNGEL. *Stahl und Eisen*, Vol. 53, Nov. 30, 1933, pages 1233-1236. An extensometer used to measure the deformations and hence the internal stresses arising about an electric-arc welded joint is described. Internal stresses as high as 16 kg./mm.^{2} were observed in plate 6 mm. thick. The stresses were greater in steel 37 (0.09% C) than in steel 52 (0.18% C; 0.51% Cu; 0.47% Cr). Covered electrodes gave higher stresses than bare electrodes. Higher Mn in the electrodes raised the stresses somewhat. Raising the current tended to lower the stresses. The stresses increased slightly in thicker plate. More rapid cooling of the weld alone raised the stresses but rapid cooling of both the weld and the plate lowered the internal stresses. SE (7b)

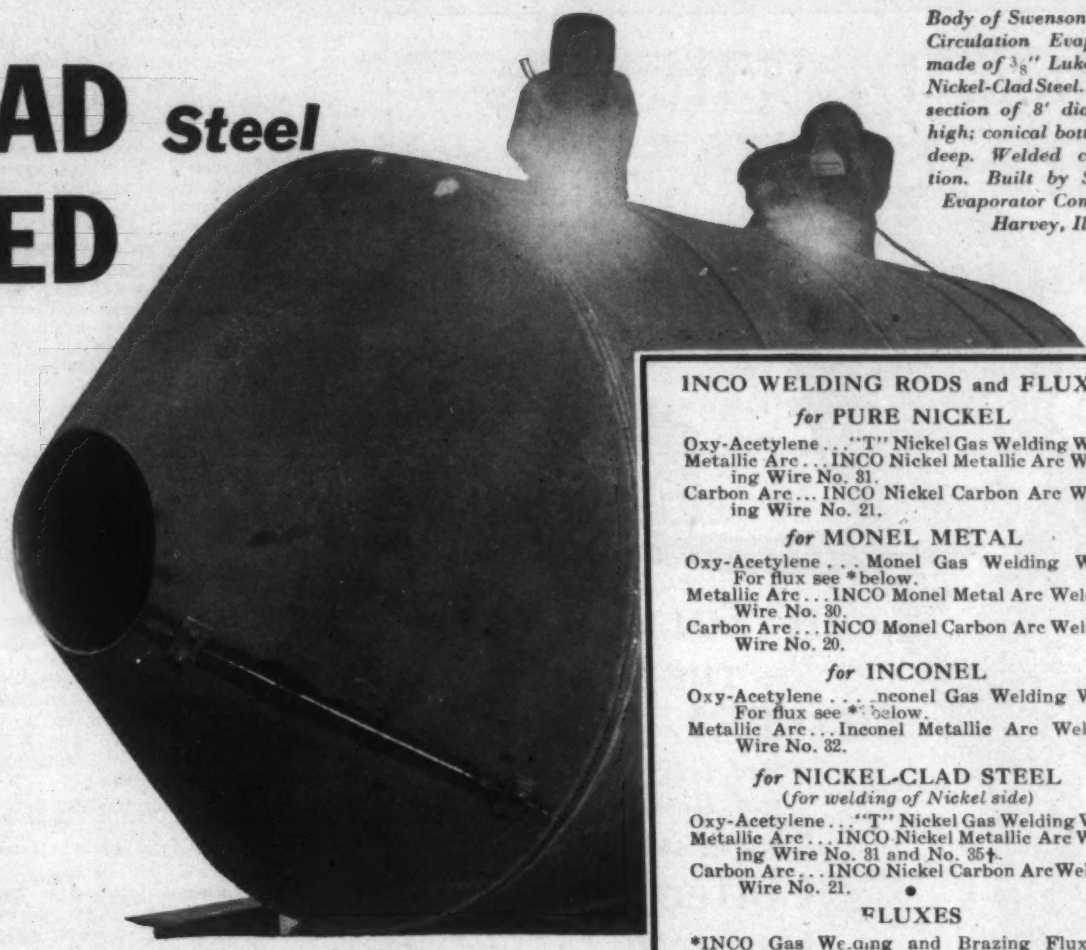
9 **Considering Design from the Production Standpoint. Part II. Forging. Part III. Welding.** HAROLD F. SHEPHERD. *Machine Design*, Vol. 5, Jan. 1933, pages 18-20; Feb. 1933, pages 22-25. The control of the metal flow in steel forgings so that the fiber is orientated to provide the greatest strength as one of the most important considerations in the design of parts to be produced by this method is discussed giving many practical examples. Part III. Discusses and illustrates use of welding for solving manufacturing problems of a delicate nature. WH (7b)

10 **Acetylene-Oxygen Welding Torch with Several Flames for Manual Operation (Azetylen-Sauerstoff-Schweissbrenner mit mehreren Flammen für Handschweissbetriebe)** E. ZORN. *Forschungsarbeiten auf dem Gebiete des Schweissens und Schneidens mittels Sauerstoff und Azetylen*, Series 8, 1933, pages 81-87. See *Metals & Alloys*, Vol. 4, Aug. 1933, page MA 258. Ha (7b)

Performance of Mild Steel Electrodes. BELA RONAY. *Sheet Metal Industries*, Vol. 7, Oct. 1933, pages 380-381. From a paper given at the Annual Meeting of the American Welding Society. See "Governing Factors of the Performance of Mild Steel Welded Electrodes," *Metals & Alloys*, Vol. 5, Feb. 1934, page MA 57. AWM (7b)

It's Lukens

NICKEL-CLAD *Steel* ...*and* WELDED



Body of Swenson Forced Circulation Evaporator, made of 3/8" Lukens 20% Nickel-Clad Steel. Straight section of 8' dia. x 12' high; conical bottom 3'7" deep. Welded construction. Built by Swenson Evaporator Company, Harvey, Ill.

IT'S BIG, this Nickel-Clad Steel job, built by Swenson Evaporator Company of Harvey, Ill. It's the body for a Swenson Evaporator, made of Lukens Nickel-Clad Steel.

And it's *welded*. On the steel side, the builders followed ordinary steel welding practice. On the Nickel-Clad side, the welders used INCO Nickel Metallic Arc Welding Wire No. 31...and produced strong, tight joints that are also proof against rust and corrosion.

Send for "*Methods for the Fabrication of Nickel-Clad Steel Plate.*"

• • •

THE INTERNATIONAL NICKEL COMPANY, INC.

Miners, refiners, and rollers of Nickel.
Sole producers of Monel Metal.

67 WALL STREET, NEW YORK, N. Y.

INCO WELDING RODS and FLUXES

for **PURE NICKEL**

Oxy-Acetylene . . . "T" Nickel Gas Welding Wire.
Metallic Arc . . . INCO Nickel Metallic Arc Welding Wire No. 31.
Carbon Arc . . . INCO Nickel Carbon Arc Welding Wire No. 21.

for **MONEL METAL**

Oxy-Acetylene . . . Monel Gas Welding Wire. For flux see *below.
Metallic Arc . . . INCO Monel Metal Arc Welding Wire No. 30.
Carbon Arc . . . INCO Monel Carbon Arc Welding Wire No. 20.

for **INCONEL**

Oxy-Acetylene . . . Inconel Gas Welding Wire. For flux see *below.
Metallic Arc . . . Inconel Metallic Arc Welding Wire No. 32.

for **NICKEL-CLAD STEEL**
(for welding of Nickel side)

Oxy-Acetylene . . . "T" Nickel Gas Welding Wire.
Metallic Arc . . . INCO Nickel Metallic Arc Welding Wire No. 31 and No. 35†.
Carbon Arc . . . INCO Nickel Carbon Arc Welding Wire No. 21.

FLUXES

*INCO Gas Welding and Brazing Flux for Monel Metal.
** "Cromalloy" Gas Welding Flux is recommended for Inconel.
† For vertical welding.
No flux is used for the gas welding of Pure Nickel or Nickel-Clad Steel.

INCO welding materials as listed can most conveniently be obtained through regular INCO distributors.
Detailed welding instructions furnished on request.

Welding of Crankshafts by Acetylene (Schweissen von Kurbelwellen mittels der Azetylenschweissung) F. WUTTKE. *Autogene Metallbearbeitung*, Vol. 27, Jan. 15, 1934, pages 25-26. Reports several cases where broken crankshafts have been perfectly soundly repaired by acetylene welding so that they are again in service from 3-5 years without fracture. No subsequent heat-treatment was applied. Ha (7b)

Examples of Steel Mains Over Bridges. H. V. WILLIAMS. *Gas World*, Vol. 98, Apr. 29, 1933, pages 419-420. The advantages of the use of steel tubes and the welding difficulties encountered on certain sized tubes are discussed, and the method of packing for protection from soil corrosion is described. MAB (7b)

New Electric Resistance Welding Machines (Neue elektrische Widerstandschweissmaschinen) H. WILBERT. *Siemens-Zeitschrift*, Vol. 13, July/Aug. 1933, pages 153-155. Full automatic butt-welding machines, rapid spot-welding machines and a seam-welding machine with electron tube control are described. The latter has particularly the function to open the current supply at a definite moment and in a definite manner in order to prevent too much heat being absorbed by the piece to be welded. Ha (7b)

The Welding of Monel Metal and Nickel. *Metal Industry*, London, Vol. 44, Jan. 26, 1934, pages 116-118; Feb. 2, 1934, pages 139-140. Both oxy-acetylene and metallic arc welding are used successfully, powdered boric acid (not borax) being the best flux for oxy-acetylene welding. In electric welding, the work must be negative instead of positive, thickness of electrode should be rather greater than that of the work. Fluxes for this process must be deoxidizers and have good slag-forming qualities so that the slag floats steadily on top and protects the metal from oxidation during solidification. Monel metal is extremely well suited as welding material for cast iron as it gives machinable welds. General instructions on procedure are given. Ha (7b)

Welded Steel Used for Diesel Engine Structure. EVERETT CHAPMAN. *Iron Age*, Vol. 132, Aug. 24, 1933, pages 27-29, 51; Aug. 31, 1933, pages 14-17; *Steel*, Vol. 93, Aug. 28, 1933, pages 31-34; Sept. 11, 1933, pages 25-27. See "Welded Steel Diesel Structures," *Metals & Alloys*, Vol. 5, May 1934, pages MA 198. MS+VSP (7b)

The Welding Machine "SA.FRAP" (La Machine a Souder "SA.FRAP"). R. MESLIER. *Bulletin de la Societe des Ingenieurs Soudeurs*, Vol. 4, Nov-Dec. 1933, pages 1126-1133; *Revue de la Soudure Autogene*, Vol. 26, Jan. 1934, pages 6-9. Lecture before French Welders' Society. Author points out that all the machines which were previously described did not use added metal, on the contrary, the machine here described uses added metal rods. This machine is entirely automatic and permits welding lengthwise seams on cylinders or to weld circumferencially rings or bottoms. This machine is based on quite same principles as used in machine tools. Welding torch is provided with a water jacket. By side of this torch there is another one with a C_2H_2-air flame which is always directed on the molten bath during the work. Added metal is wound over a reel and automatically fed over the torch through a copper nozzle the end of this added metal rod being given mechanically a rotary motion. A workman can operate 4 machines of this type. Appearance of seams made with this type of machine is much better than that of hand welded seams. FR (7b)

Electric Welding in Warship Construction (Het electrisch lasschen in den oorlogsheepbouw). *Polytechnisch Weekblad*, Vol. 27, Aug. 31, 1933, page 549. Discusses lecture of C. S. Lillicrap before the Institution of Naval Architects. See "Use of Electric Arc Welding in Warship Construction," *Metals & Alloys*, Vol. 5, May 1934, page MA 202. WH (7b)

Welding Capacities for Semi-Automatic and Machine Gas Welding (Leistungswerte beim halbautomatischen und maschinellen Autogenschweissen). E. ZORN. *Autogene Metallbearbeitung*, Vol. 27, June 1, 1934, pages 177-182. A general investigation into the economy of welding processes as it depends on 1. welding time, 2. gas consumption, 3. welding method, is made by experiment and by review of other publications on the subject. It is attempted to develop characteristic figures so that a common basis may be found for correct comparison of economy of welding processes. Ha (7b)

6

Melting Speed of Electrodes (Schmelzgeschwindigkeit von Elektroden). V. P. WOLOGDIN. *Die Elektroschweissung*, Vol. 4, Oct. 1933, pages 188-191. Investigations endeavor to elucidate in how far speed of welding process and loss of metal by evaporation and atomization are affected by different factors in arc welding. Following factors were studied: type of current, amperage, type of electrodes, type and properties of electrode coating, polarity, location of weld seam. Amperage in d.c. welding: Within range of common welding currents loss of electrode metal by gasification and atomization shows no characteristic dependence on current. Following average data were found: loss through gasification and atomization 8.2%, loss through electrode waste 12.5%, electrode metal actually deposited in the weld 79.3%. In a.c. welding loss through evaporation and atomization is much lower than for d.c. welding, as table shows.

7

Of 100 g of electrode are	d.c.	a.c.
utilized in welding	90.6 g	94.2 g
Lost through evaporation, etc.	9.4 g	5.8 g

Decrease of losses by gasification and atomization in a.c. welding is exclusively due to shorter arc. Effect of coating pastes on melting speed and metal loss was studied. Electrodes 4 mm. in diameter at 120 ampere current were used; melting coefficient (g. of electrode melted/amp. hr.) is decreased by paste. Melting coefficient decreases due to coating by about 28-30% for common horizontal as well as overhead welding. Melting coefficient depends slightly on operating amperage. It decreases somewhat with increasing current. With still higher current, melting speed is alike for a.c. and d.c. welding. Electrode coating had no particular effect on loss by evaporation and atomization. Effect of seam location: Melting speed in overhead welding is much lower than in normal horizontal welding, for non-coated electrodes by about 20%, for coated ones by about 40%. This holds true for both coated as non-coated electrodes. GN (7b)

8

Manufacture of Welded Steel Bottles (Herstellung geschweisster Stahlflaschen). A. WIEGAND. *Autogene Metallbearbeitung*, Vol. 27, Apr. 15, 1934, pages 121-123. Manufacturing and welding processes for steel bottles as containers for compressed gases are described. Ha (7b)

Strength of Fusion Welded Seams in Mild Steels (Propieta resistenti delle saldature autogene su acciaio dolce). G. SIROVICH. *La Metallurgia Italiana*, Vol. 25, Nov. 1933, pages 799-824. Continuation of a serial article. See *Metals & Alloys*, Vol. 5, June 1934, page MA 266. AWC (7b)

9

Welded Structures in Automobile Construction (Schweisskonstructionen im Autobau). V. WALTER. *Der Autogen Schweisser*, Vol. 7, Feb. 1934, pages 13-17. Discussion of details of the application of welding in the construction of the chassis and presentation of new proposals. The possibility to produce joints having the lowest possible weight, to place the weld anywhere but at the place of highest stress and to construct a frame of sufficient flexibility give the autogenous welding an extensive field in automobile construction. Examples are critically discussed by means of drawings showing designs which must lead to failures and giving designs suitable for the application of autogenous welding. Kz (7b)

10

Welding of Aluminum (Aluminiumschweissungen). VICTOR WALTER. *Der Autogen Schweisser*, Vol. 7, Apr. 1934, pages 50-53. Discussion of technique employed in welding Al alloys. Welding rods and a rod for built-up repair work are dealt with. Preheating and treatment of welds to prevent stress concentration and corrosion are discussed. Kz (7b)

Theo. De Witt Says—

After October 1st

In TOLEDO It's

THE NEW

HOTEL SECOR

Completely Renovized and Re-equipped

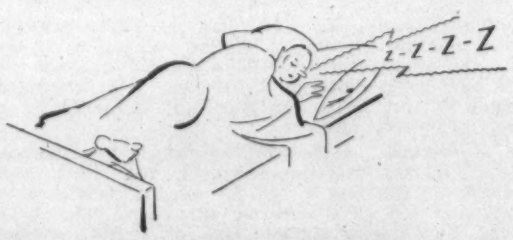
POPULAR PRICED

Coffee Shop

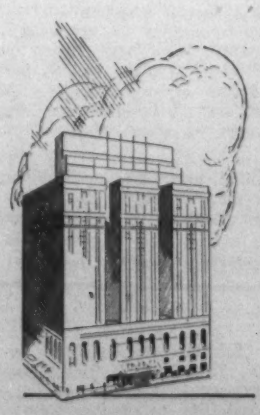
AND

Parisian Cocktail Bar

Rates from—$2.50 Single—$4.00 Double



...HAVE YOU HEARD *the one about the traveling salesman?*



He went to bed at the William Penn and slept twenty years! Well, maybe that is a little exaggerated. But anyway, the beds at Pittsburgh's number one hotel are so comfortable you don't ever want to get up. The food in the four famous restaurants is equally exceptional, and the prices reasonable. Quiet, well-furnished rooms, $3.50 single; $5.00 double, all with bath.

1600 ROOMS . 1600 BATHS

HOTEL WILLIAM PENN

PITTSBURGH, PENNA.

Welding Progress Facilitates Bridge Reconstruction and Repair. ANDREW VOGEL. *Iron Age*, Vol. 132, Sept. 28, 1933, pages 18-23. Development of heavily-coated electrodes with properties equal to structural steel has made possible the use of welding for strengthening and fabrication of highway and railroad bridges. Gives results of tension, bend, impact shear and other tests that show the suitability of welding. VSP (7b)

Study on Internal Stresses in Welds (Etude sur les Tensions Internes dans les Soudures). E. VARRIOT. *Arts-et-Métiers*, Vol. 87, Jan. 1934, pages 1-6. Points taken in account in this study are the following ones: (1) Determination of heat brought in a given point. (2) Determination of importance of metal elements affected by this heat supply. (3) Determination of repartition of temperatures in these heated elements. (4) Determination of cooling curves of these elements. (5) Knowledge of elastic strength of common metals and particularly of mild steel at different temperatures. The author explains each of these 5 items and concludes his study as follows: elastic stresses can exist only when molten metal has reached a sufficient frozen state to resist elastically to expansion stresses imparted to it by surrounding element solid. As a consequence any condition which will keep molten metal in low strength state and at the same time will allow surrounding metal to cool normally or any condition which, on the contrary, will accelerate cooling of surrounding metal during freezing of most heated portion will lessen resulting internal stresses in the weld. FR (7b)

Electric Welding of Traveling Grates (Die Elektroschweissung beim Bau von Wanderrosten). FRITZ SIEGLE. *Die Elektroschweissung*, Vol. 5, May 1934, pages 88-90. After discussing former objections advanced against application of electric welding for mentioned purposes advantages resulting from electric welding are pointed out; ease of construction and mounting, saving of weight and subsequent shipping freight and duties. Details of welded parts of such machinery are described and shown. Former and new methods of construction are compared. GN (7b)

Using Tests to Determine Current Set-Up and Procedure for Welding. J. THOM. *Welding Engineer*, Vol. 19, Mar. 1934, pages 24-26. Extensive experiments were made with different types of electrodes, welding procedures, testing etc. High currents were found to be conducive to good welding and are particularly advantageous for the elimination of slag and gas holes; an amperage of 70-100% above what is normally used today can safely be used, and is not detrimental to the parent metal. Also from the cost point of view the high current is better. Slag inclusions and oxidation accelerate corrosion. Methods for making fatigue tests are briefly described. Ha (7b)

Welded Construction Cuts Cost of Perforating Dies in Half. C. M. TAYLOR. *Machinery*, N. Y. Vol. 40, Sept. 1933, page 24. Welded dies for punching holes in steel parts proved superior to cast iron in maintenance and weight. VSP (7b)

Fabricates Large Gear Cases by Arc Welding. C. M. TAYLOR. *Steel*, Vol. 92, Feb. 20, 1933, pages 21-22. United Engineering & Foundry Co. used welded steel-plate construction in building gear-cases for a drive for a continuous plate-mill. MS (7b)

Welding in the Steel Industry—Fabrication of Steel Mill Machinery. C. M. TAYLOR. *Iron Age*, Vol. 131, June 29, 1933, pages 1024-1027. The first installment was published in April 20th issue of Iron Age. Outlines some of the results obtained by arc welded construction in various large steel mills. VSP (7b)

Welding in the Steel Industry—Heavy Equipment Applications. C. M. TAYLOR. *Iron Age*, Vol. 132, July 6, 1933, pages 16-17, 68. Covers the application of welding to a soaking-pit-crane lifting ram, roll changing hook and an open-hearth charging machine. These unrelated types of equipment provide exceptionally severe tests of welded construction. VSP (7b)

Design and Development of Simple, Welded Parts (Konstruction und Werdegang einfacher, geschweisster Teile). HERBERT SEIDEL. *Der Autogen Schweisser*, Vol. 6, 1933, pages 95-97; Nov. 1933, pages 133-134; Vol. 7, Jan. 1934, pages 4-6. Pointing out that too little attention has been paid to the application of welding in the manufacture of simple parts such as handles, cranks, wheels, tables etc. the author discusses and illustrates their design and the welding technique to be employed. Dealing with the manufacture of small iron constructions, the employment of welding and riveting are critically compared. Kz (7b)

Physical Properties of Gas and Arc Welds for Structural Steels of Higher Strength (Physikalische Eigenschaften von Gasschmelz-und Lichtbogenschweissen bei Baustählen höherer Festigkeit). F. SOMMER. *Forschungsarbeiten auf dem Gebiete des Schweissens und Schneidens mittels Sauerstoff und Azetylen*, Series 8, 1933, pages 63-88. See *Metals & Alloys*, Vol. 5, May 1934, page MA 195. Ha (7b)

Types of Resistance Welds and How They are Used. F. S. STICKNEY. *Product Engineering*, Vol. 5, May 1934, pages 162-165. The use of resistance welding particularly of small parts in instrument making, is pointed out and a number of applications illustrated. A table giving the combinations of metals suitable for resistance welding is included. Ha (7b)

Automatic Arc Welding Apparatus (Lichtbogen-Schweissautomaten). E. THIEMER. *Die Elektroschweissung*, Vol. 5, Mar. 1934, pages 49-51. According to welding work to be done and most suitable type of seam for part in question either automatic "wire" or "carbon" welding machines are used. Constructions of both types of welding heads are described at length, points to be observed in application are considered. For high quality seams made at high speed an automatic Arc-atom welding apparatus has been developed recently. GN (7b)

Riveting (7c)

High Pressure Bottled Gas for Riveting. *Railway Engineering & Maintenance*, Feb. 1934, pages 76-77. Considerable saving through the use of cylinder nitrogen in place of compressed air for small bridge repair projects is claimed. A 200 cu. ft. cylinder of N drives 25 rivets (⅞") in 12 min. at a total cost of $2.93 or an average cost per rivet of $0.117 of which $0.025 was for labor and $0.092 for gas. The savings are the larger the smaller the riveting jobs. WH (7c)

Practical Notes on Light Metal Work. A. EYLES. *Mechanical World & Engineering Record*, Vol. 91, Apr. 29, 1932, pages 407-408. It is possible to make satisfactory and strong joints in thin sheet metal by riveting into recesses instead of plain holes. A practical difficulty has been to prevent the rivet buckling due to the flexibility of the thin sheets. The method of riveting, different types of rivets and rivet heads are discussed and examples are given. Kz (7c)

Strength of Rivets in the Reinforcing Butt Straps of Girders (Die Nietkräfte in den Verstärkungslaschen von Biegeträgern) J. CASSENS. *Zeitschrift für Flugtechnik und Motorluftschiffahrt*, Vol. 24, Feb. 28, 1933, pages 103-107. Derivation of formula and discussion of examples. Kz (7c)

Gun Powder in the Service of Metal Working. (Schiesspulver In Dienste der Metallbearbeitung.) CHESTER B. LORD. *Zeitschrift Verein deutscher Ingenieure*, Vol. 76, Dec. 3, 1932, pages 1205-1206. Reports on an American method of shooting bolts into metal plates by means of a pistol which is similar to a compressed air hammer; the amount of powder depends on diameter of bolt. Method can be applied also under water. Tests have shown that it is quite possible to replace threading by shooting the bolts in. A few data of plates joined in this manner are given. Ha (7c)

FINISHING (8)

H. S. RAWDON, SECTION EDITOR

Pickling (8a)

Pickling Blisters on Galvanized and Black Steel Sheet (Beizblasen auf Zink und Stahlblechen). O. VOGEL. *Stahl und Eisen*, Vol. 54, May 3, 1934, pages 446-450. On immersing different galvanized sheets into acid solutions containing no inhibitor, blisters appeared on some and not on others. The blisters apparently originated in the pickling of the sheets before galvanizing, being similar in appearance to blisters which sometimes form in pickling black sheet. SE (8a)

Simplicity in Acid Cleaning Plant. RICH. SAXTON. *Wire and Wire Products*, Vol. 9, June 1934, pages 174-176, 191. Layout, equipment and handling of material in a British cleaning plant with HCl is described. (Number of operations is reduced to the minimum.) Ha (8a)

Pickling Strip Steel in a Continuous Unit. F. L. PRENTISS. *Iron Age*, Vol. 133, Mar. 29, 1934, pages 28-30. Describes a continuous unit built by Broden Construction Co. for the Wallinford Iron Co. Advantages of continuous method of pickling over the batch method are emphasized. VSP (8a)

Cleaning, including Sand Blasting (8b)

The Fettling Shop and Efficiency. W. G. MORGAN. *Foundry Trade Journal*, Vol. 49, Dec. 14, 1933, pages 337-339. Morgan emphasizes the importance of the finish of a casting and the value, therefore, of careful cleaning, etc. Pneumatic tools and grinding wheels, sand-blasting, and a recent development in shot-cleaning which involves using centrifugal force to apply the steel shot at high pressure are described. Use of high-pressure water is also referred to. Consideration is given to labor problems and safety devices. OWE (8b)

Polishing & Grinding (8c)

Spring Collets Finished by Grinding. FRED B. JACOBS. *American Machinist*, Vol. 78, May 23, 1934, pages 372-373. Sequence of operations and methods are described. Ha (8c)

Studies on the Efficiency of Razor-Hones. MASAW KURODA & DAIZYUK YAMADA. *Bulletin Institute of Physical & Chemical Research, Tokyo*, Vol. 13, Apr. 1934, pages 314-322. (In Japanese.) *Scientific Papers & Abstracts Institute of Physical & Chemical Research, Tokyo*, Vol. 24, Apr. 1934, page 23. (In English.) A new apparatus has been designed for measuring the cutting power of safety razor blades. For testing the razor-hone, the blades are first dulled by shaving piles of velvet over a definite area and then sharpened by a hone. The cutting power of the blades and the efficiency of hones were thus determined in one test. WH (8c)

The M.B.V. Surface Treatment for Aluminum and Its Alloys. GUSTAV ECKERT. *Foundry Trade Journal*, Vol. 49, Nov. 16, 1933, pages 281-282. Extended abstract of publication by the British Aluminum Company. See "MBV-Process, an Effective Surface Protection for Aluminum and its Alloys," *Metals & Alloys*, Vol. 3, June 1932, page MA 162. OWE (8c)

Rotary Grinding Before Plating. FRANCIS A. WESTBROOK. *Metal Industry*, N. Y., Vol. 31, Dec. 1933, page 405. General description of preparation of surfaces of steel bed plates by means of rotary surface grinder. Magnetic chucks were used for holding the plates. Demagnetization of the plates was necessary before nickel and chromium plating. PRK (8c)

The Wide Range of Gear-Tooth Grinding. FRED A. WARD. *Machinery*, N. Y., Vol. 40, Mar. 1934, pages 385-389. Methods and tools are described. Ha (8c)

Use of Hard Fabrics Impregnated with Artificial Hard Resin in Grinding Technique (Die Verwendung von Kunstharz-Hartgeweben in der Schleiftechnik). HOLM. *Oberflächentechnik*, Vol. 11, May 15, 1934, pages 115-116. Hard cotton fabrics are impregnated with artificial resins (bakelite) and used for grinding and lapping, the hard fabric is the grinding element, not the resin; the effect is increased by additional abrasives such as emery, pumicestone, etc., which stick better on this tissue than on wood. The abrasive is mixed with oil and put on the wheel. Wear is not very great. The method has been used successfully fairly recently. Ha (8c)

Grinding Machines in Locomotive Maintenance. K. POTYKA. *Engineering Progress*, Vol. 15, May 1934, pages 91-93. Special grinding machines for inside crank journals on wheel sets, twin grinders for axle-box guides, for crank-pins, and other locomotive parts are described. Ha (8c)

Grinding Machine for Spur and Helical Gears (Stirn-and Schraubenrad-Schleifmaschine). P. ULICH. *Zeitschrift Verein deutscher Ingenieure*, Vol. 78, Apr. 21, 1934, pages 493-494. Description of a machine which grinds gears up to 1200 mm. diam., 300 mm. width of tooth and 25° angle of helical gears with an accuracy of 0.001 mm. Ha (8c)

Electroplating (8d)

Reduction of Polonium in Solution (Sur la Réduction du Polonium en Solution). M. GUILLOT & M. HAISSINSKY. *Comptes Rendus*, Vol. 198, May 28, 1934, pages 1911-1913. Reducing agents such as hydrazine, oxalic and formic acids, etc., change potential for Po necessary for electro deposition partly by formation of complex Po ion and partly by reduction of normal ions of Po to lower valence. FHC (8d)

Electro-Metallurgical Progress in 1933. S. WERNICK. *Industrial Chemist*, Vol. 10, Jan. 1934, pages 13-15. Résumé of published work on electro deposition of Cr, Ni, Cd, and the rare metals. Molten electrolytes are also discussed. 15 references. RAW (8d)

The Influence of Mercury on the Electrolytic Absorption (of Hydrogen) by Iron (Ueber den Einfluss des Quecksilbers auf die elektrolytische Wasserstoffaufnahme des Eisens). H. PLOUM. *Zeitschrift für Elektrochemie*, Vol. 40, May 1934, pages 267-270. Investigations of H absorption of Fe (during electrolysis) have shown that this is dependent on the presence of a catalyzer; Hg forms such catalyzer, in alkaline and in acid solutions. Ha (8d)

Problem of Chromium Plating of Nickel (Zur Frage der Verchromungsfähigkeit von Nickelschichten). JOACHIM KORPIUM, ERNST VOGEL & KARL SCHNEIDER. *Die Naturwissenschaften*, Vol. 22, Mar. 2, 1934, page 135. Flaking of Cr deposits on Ni cannot be ascribed to the H_2 content of the underlying Ni. Success of Cr plating depends on ability of the H_2 originated electrolytically in the Ni carrier to diffuse. The higher the diffusion constant the greater the tendency toward flaking of Cr. Diffusion constant is affected by the current density during plating and by grain size. EF (8d)

Information for the User About Chromium Plate. MARVIN J. UDY. *Metal Progress*, Vol. 23, Dec. 1933, pages 24-27, 62. Failure of chromium plating in many instances is attributable to lack of appreciation of the properites of the metal and the fact that it is applied as a very thin film. Undercoats and their preparation are important for decorative applications. WLC (8d)

NEW OPERATING MANUAL

for

COPPER . . . BRASS . . . BRONZE . . . ZINC PLATING

from Cyanide Solutions

"Operating Manual for Copper . . . Brass . . . Bronze . . . Zinc Plating with du Pont Copper and Zinc Cyanides"

FREE—MAIL THE COUPON

This new manual discusses such subjects as:

- **Effect of Freedom from Inert Salts on Speed, Cost of Plating, and Ease of Solution Control**
- **Commercial Value of Metal Cyanide Solutions Over Acid Solutions**
- **Copper Plating Preparatory to Localized Hardening of Steels**

This booklet has been prepared to place in the hands of platers information on standard methods of using Copper Cyanide and Zinc Cyanide. The operating section of the manual gives specific instructions on making up plating solutions, solution formulas, operating conditions, methods of analyzing the solution, and cleaning of metals prior to plating.

Copies are available on request

The attached coupon is for your convenience

DU PONT

R&H Chemicals *for Electroplating*

THE R. & H. CHEMICALS DEPT.
E. I. DU PONT DE NEMOURS & CO., INC.
WILMINGTON, DELAWARE

GENTLEMEN: Please send me a copy of your new "Operating Manual for Copper . . . Brass . . . Bronze . . . Zinc Plating with du Pont Copper and Zinc Cyanides."

I am particularly interested in plating_____
(Type of Article)

*Name*_____

*Position*_____

*Company*_____

*Address*_____

Non-poisonous Electroplating Baths (Ueber nicht-giftige galvanische Bäder). H. Gockel. *Zeitschrift für Elektrochemie*, Vol. 40, June 1934, pages 302-303. Experiments were made to replace the highly toxic cyanide bath for Cu, Ag, and Au plating by non-poisonous baths; very satisfactory results were obtained with complex salts of thio-urea. A suitable salt is $AgThi_3$ NaO_3, wherein "Thi" represents CS $(NH_2)_2$; the bath is made by stirring a silver nitrate solution in a thio-urea solution at 30°-40° C. Ag deposit of great hardness on Cu was obtained in a bath of 25-30 g. $AgNO_3$ and 60-70 g. thio-urea in 1 l. H_2O, temperature 30°-35° C., voltage 1.5, current density 0.2 amp./dm.²; anode of Ag, cathode of Cu or brass. The bath must be stirred. For Cu-plating, $[CuThi_3]$ Cl was employed; it was obtained by adding CuCl to a 20% thio-urea solution at 40° C. A simplified method to prepare thio-urea on a large scale is described. The great advantage of these solutions is their absolute non-toxicity. Ha (8d)

Silver and Gold Coating of Aluminum. (Versilbern und Vergolden von Aluminium). G. Huth. *Aluminium*, Vol. 16, Mar. 15, 1934, pages 1-2. See *Metals & Alloys*, Vol. 5, June 1934, page MA 273. Ha (8d)

The Electro-Deposition of Iron-Cobalt Alloys. II. S. Glasstone & J. C. Speakman. *Metal Industry, London*, Vol. 42, Mar. 3, 1933, pages 259-260. See *Metals & Alloys*, Vol. 5, May 1934, page MA 206. Ha (8d)

Electrolytic Deposition of Tantalum from Aqueous Solutions (Die elektrolytische Abscheidung von Tantal aus wässerigen Lösungen). N. Isgarischew & A. F. Prede. *Zeitschrift für Elektrochemie*, Vol. 40, June 1934, pages 295-297. Electrolytic deposition of Ta from aqueous solutions, especially those containing organic additions was investigated; solutions with glucose, potassium-salicylate or resorcin gave satisfactory results, but in the 2 first metal deposition ceased shortly after beginning the test and the efficiency was very low. Resorcin solution did not show this cessation of deposition. Metal deposition is possible only if anode and cathode are not separated by a diaphragm so that it seems that the electrolyte is prepared for metal deposition by an anodic process the nature of which could not yet be found. Ha (8d)

Theory of Chromiumplating (Theorie der Verchromung). E. Liebreich. *Zeitschrift für Elektrochemie*, Vol. 40, Feb. 1934, pages 73-86. The principles underlying deposition of Cr from chromic acid solutions were investigated. Cr can be deposited cathodically only in bivalent state. The current-potential curves of the deposition have quite different character according to whether the electrolyte contains only chromic acid or other acids are present. The potential-current density curves show 2 branches with pure chromic acid when Au electrodes are used; the positive branch changes with concentration and becomes more negative as time elapses, which is the shorter the higher the current density. If Pt electrodes are used 3rd branch appears in the curve caused by H discharged at the cathode: H is discharged without any deposition of Cr at 0 volt. The addition of other acids to chromic acid divides the 2 branches of the current-potential curve into 4 parts for Au and 5 parts resp. for Pt cathodes. These 4 branches have practically the same position independently of kind of other acid, and distinguish themselves only by the different current density for the same potential. The change from positive to more negative values occurs here also. Acids used as additions were H_2SO_4, HF, H_2SiF_6, HCl, $HClO_3$, $HClO_4$, HBr, HI, HNO_3, H_3PO_4, and others for which the particular effects are given in detail. The fact that reduction to bivalent Cr takes place does not in itself determine the possibility of practical deposition; solubility of the oxide, structural nature of the formed salt, and the solubility of Cr metal in the added acid are of importance. Au cathodes become covered during electrolysis with a thin film which increases considerably the voltage necessary for the discharge of H; with Pt cathodes, however, the film is hardly noticeable and H is discharged with almost no increase of potential. The observed change from positive to more negative potentials in the positive branches of the curves is due to saturation of the cathode with H, in the case of Au by the intermediary of the oxide film, in that of Pt directly. The change is not due, as was assumed generally, to the occurrence of a contact resistance on account of the formation of the oxide film. 15 references. Ha (8d)

Adherence of Electrolytic Deposits of Copper (Sur l'Adhérence des Dépôts Électrolytiques de Cuivre). P. Jacquet. *Comptes Rendus*, Vol. 198, May 28, 1934, pages 1909-1911. Adherence of electrodeposited Cu was studied by using Ni plated steel as the basis. Degree of adherence varied greatly with surface finish:

Ni surface roughened with emery	1200 g.
Ni surface polished	9000-12000 g.
Ni surface as deposited electrolytically	4000-6000 g.

Adherence varied also with "tension of solution" (measured by change in cathode distance):

displacement of cathode (after 20 min. electrolysis)

1.46 mm.	10900 g.
2.48 mm.	5700 g.
5.18 mm.	550 g.

Solution changes with use. After 70 hrs. the "tension" corresponded to 2.90 mm. whereas initially 4.76 mm. Adhesion strength increased, correspondingly, 550 g. to 4800 g. FHC (8d)

Hard Rubber. D. D. Wilkins *Metal Industry*, N. Y., Vol. 32, Feb. 1933, pages 53-54. The usefulness of rubber in the plating industry is discussed. PRK (8d)

Structure of Electrolytic Copper Obtained in Presence of Certain Colloids (Sur la structure des dépôts électrolytiques de cuivre obtenus en presence de certains colloides). P. Jacquet. *Comptes Rendus*, Vol. 198, Jan. 3, 1934, pages 74-76. Jacquet studied the effect of gelatine, seralbumin, gum arabic, gum tragacanth, dextrine (all colloids), and also of glycocoll on the structure of copper deposited in baths containing from 1 mg. to 5 g. of each of the above substances per litre of electrolyte (125 g. $CuSO_4$ and 25 g. H_2SO_4 per litre). Electrolysis was carried on for 5 hrs. at 18-20° C. (2 amp./dcm.²). Samples of the deposits for microscopic examination were plated first with nickel, then heavily with copper and a section normal to the surface of the deposit was polished, etched, and examined at 500-1000 diameters. On the basis of the effect on the structure of copper, the substances treated were classified as follows:—

Very active; gelatine, seralbumin.
Moderately active; gum arabic, gum tragacanth.
Practically inactive; dextrine, glycocoll.

This classification is identical to one obtained by studying the action of these substances on the stresses in copper deposits. The active substances are those most readily adsorbed. OWE (8d)

Influence of Electrolyte Concentrations on Potential for Polonium Deposition (Effet des Fortes Concentrations d'Électrolytes Sur le Potentiel de Dépôt du Polonium). M. Guillot & M. Haïssinsky. *Comptes Rendus*, Vol. 198, May 14, 1934, pages 1758-1760. Confirmation of statement of previous authors that acidity of Po nitrate can be raised to 4N without changing potential of Po deposition on gold cathode which is + 0.37 volts (± 0.02) referred to a normal calomel cell. Other acids however were as follows:

4N H_2SO_4 with potential for Po deposition
0.10 volts (± 0.06)
1.12N acetic with potential for Po deposition
0.24 volts.

Curves included to show variations of potential as a function of $NaNO_3$ concentration in N HNO_3 and Na_2SO_4 concentration in 0.95 NH_2SO_4.

K ferro cyanide suppresses deposition of Po.

In neutral solutions, Po can be plated with rate of deposition comparable to that in acid solution as follows:—

3.5 N $NaNO_3$ with potential + 0.13 volts
2.3 N K_2SO_4 with potential 0.25 volts. FHC (8d)

Metallic Coatings other than Electroplating (8e)

New Copper Plating Bath. *Iron Age*, Vol. 131, May 18, 1933, page 781. Brief abstract of paper read before the Electrochemical Society. See "A Cyanide-Free Bath for the Deposition of Copper on Steel," *Metals & Alloys*, Vol. 5, June 1934, page MA 271. VSP (8d)

Installations and Processes for Galvanizing (Galvanisierverfahren und -anlagen). R. Justh. *Oberflächentechnik*, Vol. 11, May 1, 1934, pages 102-103. Brief review of practical points, testing of baths, testing of deposits, and common defects of deposits. Ha (8e)

The Structure of Metallic Layers Prepared by Condensation of Metal Vapor on Cooled Surfaces (Die Struktur metallischer Schitchten, die durch Kondensation von Metalldampf auf einer gekühlten Oberfläche hergestellt wurden). M. J. Gen, J. Zelmanoff & A. J. Schalnikoff. *Physikalische Zeitschrift der Sowjetunion*, Vol. 4, 1933, pages 825-834. The structure of films of Ni, Fe, Cd, and Hg deposited in a vacuum at temperatures down to —183° C. were studied by the electron diffraction method, the recrystallization phenomena in the metallic deposits traced and conclusions on the mechanism of the condensation of metal vapors are set forth. Under all testing conditions, the deposited metallic layer exhibited the same crystalline structure as the ordinary metals. The artificially prepared metal films only showed dispersion to an extreme degree. EF (8e)

Eliminates Dross and Reduces Zinc Contamination in Galvanizing. W. H. Spowers, Jr. *Steel*, Vol. 93, July 24, 1933, pages 23-25. Same as *Wire & Wire Products*, Vol. 8, June 1933, pages 165-167, 184. See *Metals & Alloys*, Vol. 5, June 1934, page MA 273. MS (8e)

Lead Coating with the Oxy-acetylene Flame (Das Verbleien mittels Azetylen-Sauerstoff-Flamme.) Leo Knez. *Der Autogen Schweisser*, Vol. 7, Apr. 1934, pages 54-56. Usually the hydrogen flame is used to produce Pb coatings free from slag but the oxy-acetylene flame has advantages when used with a slight excess of acetylene. After pickling the Fe surface with HCl it must be tinned. An alloy containing 40% Pb and 60% Zn is recommended. Pb is applied to the heated and tinned surface in parallel runs which are later smoothed down with a pneumatic hammer. Details concerning working time, consumption of materials, and technique necessary to secure firm adherence of coating are furnished and examples discussed. Kz (8e)

Chemistry of Using Glycerin as Flux Conditioner in Hot Galvanizing. Wallace G. Imhoff. *Steel*, Vol. 94, May 21, 1934, pages 23-25. $CaH_2(OH)_2$ (in the flux) has a double function by supplying and holding H_2O. By reaction with NH_4Cl and free HCl usually present in the flux, glycerol chlorides are formed, H_2O being liberated. It is this H_2O that gives the flux its good working qualities. H_2O is essential as the medium through which the flux acts and by which the chemical reactions proceed. It renders the flux fluid enough to slip off the work easily and not burn on to it. A good flux is glistening and shining and rises to the surface as the work is submerged under the molten Zn. A thin flux is particularly desirable on work containing seams and crevices in which the flux can lodge. MS (8e)

Tin-iron Alloy in Tinplate with Notes on Some Imperfections. W. E. Hoare. *Iron & Steel Institute*, Advance Copy No. 9, May 1934, 12 pages. Methods were developed for polishing Sn-plate samples to show the alloy layer. The alloy is $FeSn_2$, the only Fe-Sn compound formed in Sn plating. The hot-water test and the modified ferricyanide test for porosity indicate exposed steel and not exposed compound. Normal pores are defined as actual holes in the plate and potential pores as areas at which the steel is exposed when the sheet is bent. The latter probably result from removal of minute areas of Sn in the later stages of the tinning process. The compound appears to be permeable to gases and evolution of gases from the steel may raise blisters in the Sn, which, when broken, form potential pores. Other defects, including mottle, dry patches, grease lines, and isolated $FeSn_2$ crystallites were studied and their causes discussed. 12 references. JLG (8e)

Non-Metallic Coatings (8f)

Asphaltum and Bituminous Lacquers (Asphalt und Bitumenlacke). H. Rabate. *Farben Zeitung*, Vol. 38, Dec. 30, 1933, page 1785. **(Utilizations industrielles diverses des produits asphaltiques et assimiles).** H. Rabate. *Peintures Pigments, Vernis*, Vol. 10, Oct. 1933, pages 187-194. Compilation of recipes for luminous coatings for insuring corrosion resistance and electric insulation respectively of ferrous and non-ferrous materials. EF (8f)

Unit Finishing of Sheets by Decalcomania Methods. Samuel P. Wilson. *Steel*, Vol. 94, June 4, 1934, page 28. Two systems are available for making ornate and complex finishes. In the first, ground coat of desired color is sprayed on metal; transfer, which includes base coat of clear lacquer and the design, is rolled on; paper is removed by H_2O; sheet is baked at 275° F. for 30-45 min.; formed; lacquered; and rubbed or polished. In the second, transfer includes a ground coat, the required design, and a clear cover coat. Metal is cleaned; transfer is moistened with a mild solvent cement and rolled on; paper is stripped off; sheet is baked at 325° F. for 1 hr.; polished; and formed. MS (8f)

Lead Paints for Gas Works. F. Williams. *Gas Engineer*, Vol. 59, Feb. 1934, page 87. The favorable corrosion-inhibiting action of red lead, and Pb chromate in primers is ascribed to the formation of a passivifying film of protective oxide which is impervious, tenacious, and self-healing. Al paint comprising Al powder as outer coat is particularly to be recommended where intermittent immersion in water is a condition of service. The usefulness of Pb base finishing paints is considered. WH (8f)

Bituminous Pipe Coatings. Wm. M. Wallace & J. A. Parks. *Journal American Water Works Association*, Vol. 25, Oct. 1933, pages 1387-1417. Review of the general subject of corrosion as applied to distribution systems and of protective coatings. Tentative specifications of the Detroit Water Board for hot application bituminous pipe coatings are included. VVK (8f)

Anodic Treatment and Dyeing of Aluminium Castings. N. D. Pullen. *Chemical Age*, London, Vol. 29, July 1, 1933, pages 6-7. See *Metals & Alloys*, Vol. 5, Mar. 1934, page MA 105. VVK (8f)

New Finish Applied to Welded Refrigerator Cabinets. F. L. Prentiss. *Iron Age*, Vol. 133, June 7, 1934, pages 12-15. The finish used on Westinghouse refrigerators is known as Dulux, a recently developed Du Pont product. Dulux coating is baked at 350° F. in primer coat oven, at 325° F. in intermediate oven and at 260° F. in finish coat oven. Outstanding new features in manufacture of the cabinets are the rustproofing of all parts by "bonderizing" the surface before applying the coating and use of electric resistance welding in fabricating the boxes. VSP (8f)

Coating and Varnishing Methods (Anstrich-und Lackierverfahren). R. Klose. *Oberflächentechnik*, Vol. 11, Apr. 17, 1934, pages 92-93. Various methods of painting or varnishing metallic or non-metallic surfaces, drying methods, equipment and bases for comparison of cost are discussed. Ha (8f)

Metal Coloring and Metal Protection by Chemical Processes (Metallfärbung und Metallschutz durch chemische Verfahren). H. Krause. *Oberflächentechnik*, Vol. 11, May 1, 1934, pages 101-102. Treatment of surface before coloring, coloring processes by chemical methods for Fe, Cu, Cu alloys and light metals are reviewed. Recently the phosphate process by Coslett has found great favor for browning of Fe as no rusting occurs afterwards. See also *Metals & Alloys*, Vol. 5, May 1934, page MA 207. Ha (8f)

TESTING (9)

Inspection & Defects, including X-Ray Inspection (9a)

C. S. BARRETT, SECTION EDITOR

Danger of Fracture and X-ray Diffraction (Bruchgefahr und Röntgenstrahleninterferenz). Discussion by F. Regler and by P. Ludwik & R. Scheu. *Metallwirtschaft*, Vol. 13, June 15, 1934, pages 427-429. Regler gives details of the procedure used in his investigations on this subject and believes that the different results obtained by Ludwik and Scheu are due to misinterpretation of some of his statements and unsuitable experimental procedure used by Ludwik and Scheu. Ludwik and Scheu claim that there is no misinterpretation and that the difference in results is due to Regler using a measuring microscope instead of photometric means to measure the width of the diffraction lines. This refers to article under same title in *Metallwirtschaft*, April 13, 1934, pages 257-261. CEM (9a)

X-Rays. Properties, Production, Uses. Radiography of Metals (Les Rayons X. Propriétés, Production, Emplois, Radiographie des Métaux). L. Persoz. *La Revue Industrielle*, Vol. 64, May 1934, pages 264-270. This first part deals chiefly with properties and production of X-rays. FR (9a)

Non-destructive Tests. E. C. Rollason. *Metallurgia*, Vol. 10, May 1934, pages 9-12. Brief descriptions of magnetic tests, acoustic tests, radiography, and fine-structure X-ray analysis. JLG (9a)

Use of Gamma Rays in Steel Foundries (L'Emploi des Rayons dans les Fonderies d'Acier). Herbert R. Isenburger. *La Revue Industrielle*, Vol. 63, Apr. 1933, pages 202-203. See "Application of Gamma Rays in Cast Steel", *Metals & Alloys*, Vol. 4, Nov. 1933, page MA 348. FR (9a)

Radium in Mechanical Engineering (Le Radium dans la Construction Mecanique). V. E. Pullin. *La Revue Industrielle*, Vol. 63, Sept. 1933, pages 452-456. See "Radium in Engineering Practice", *Metals & Alloys*, Vol. 5, June 1934, page MA 274. FR (9a)

Sensivitity of the Gamma-Ray Method of Radiography. John T. Norton & Alfred Ziegler. *Transactions American Society for Metals*, Vol. 22, Mar. 1934, pages 271-288. By taking radiographs of various thickness of low C steel with radon (radium emanation) and measuring the density of resulting films on a densitometer the sensitivity of the method was measured. Taking a 2% change in density as the smallest that can be detected it was found that defects 1.3% of the thickness of the object radiographed could be detected with thicknesses from 2 1/2" to 6". WLC (9a)

Sensivitity of X-Ray Examination of Metal Defects. Lester E. Abbott. *Iron Age*, Vol. 133, May 24, 1934, pages 12-14, 72. Orientation of defects to incident rays is of considerable importance. Cracks lying at angles to path of radiation tend to give diffused rather than clear cut images. Gives results of tests made by using artificial cracks in steel plate 1" thick. Limiting cross-sectional area of crack which could be distinguished on 1/2" steel plate under best radiographic conditions was 0.000035 in.^{2} representing a crack with depth of 0.007" and width of 0.005". Compares X-rays and gamma-rays. VSP (9a)

Physical & Mechanical Testing (9b)

W. A. TUCKER, SECTION EDITOR

Abnormal Creep During Transformation of Metals and Alloys. Keiji Yamaguchi & Kozo Nakamura. *Journal Society of Mechanical Engineers*, Vol. 36, Sept. 1933, pages 605-611. (In Japanese.) See *Metals & Alloys*, Vol. 5, June 1934, page MA 289. Kz (9b)

Change in Shape and Stress Distribution near the Yield Point of Low Carbon Steel (Formänderung und Spannungsverteilung in der Nähe der Streckgrenze bei Flussstahl). K. Yuasa. *Archiv für das Eisenhüttenwesen*, Vol. 7, Feb. 1934, pages 489-491. Steel tubes with differing ratios of wall thickness to diameter were tested in torsion. After passing the lower yield point all portions of the sample twisted equally, but between the upper and lower yield points the twist along a longitudinal segment differed appreciably. Fry etchings of cross-sections of solid samples tested in torsion showed wedge shaped radial strain lines. SE (9b)

Optical Creep in Photo-elastic Experiments. Kameiti Yuasa, Shinji Fukui, Tadashi Onishi. *Journal Society of Mechanical Engineers*, Vol. 36, July 1933, pages 447-452. (In Japanese). Paper read before the Meeting of the Society of Mechanical Engineers at Sendai, Jan. 23, 1932. Deals with the phenomena of optical and stress creep observed in loading experiments with models made from Phenolit and Zelluloid. Kz (9b)

Relation of the Size of the Test Specimens on the Brinell Hardness of Metals. Hirosi Yamanouti. *Journal Society of Mechanical Engineers*, Vol. 36, Dec. 1933, pages 835-847. (In Japanese). Paper read before the 2nd General Meeting of the Society of Mechanical Engineers, Apr. 7, 1932. Discussion of research work showing the influence of the dimension of test pieces in Brinell hardness tests. Dealing with the calculation of stress distribution in the vicinity of the indentation the effect which the dimension of the specimens exerts upon the value of constants in the equation is pointed out. Kz (9b)

Notch Sensitivity of Steels (Kerbempfindlichkeit von Stählen). A. Thum & W. Buchmann. *Archiv für das Eisenhüttenwesen*, Vol. 7, May 1934, pages 627-635. Notch sensitivity was calculated as a function of the relation between the tensile strength and endurance limit of notched specimens. Notch sensitivity results from the inability of the metal to flow plastically and thus neutralize stress concentration at sharp notches. The notch sensitivity of 11 steels ranged from 0 for an 18-8 stainless steel, to 0.92 for a 0.4% C, 3.5% Ni, 0.6% Cr steel heat treated to a tensile strength of 115 kg/mm.^{2} Most of the medium strength structural steels had a notch sensitivity of about 0.5. In general notch sensitivity increased with tensile strength although there was considerable scatter. In discussion it was brought out that though the notched-bar impact resistance may frequently give an indication of the sensitivity to notching in endurance tests—and hence of the notch sensitivity, yet the latter and impact resistance are not the same. In fact a steel with a higher impact resistance may show a greater decrease in endurance limit because of notching than a steel with a lower impact resistance. SE (9b)

The Relative Elasticity of Engine Crank Shafts. Wm. C. Stewart. *Engineer*, Vol. 157, May 25, 1934, pages 537-540. Reprinted from the *Journal American Society of Naval Engineers*, Vol. 46, No. 1, Feb. 1934, pages 31-44. The paper is entitled "Experiments to Determine Relative Elasticity of Modifications of Main Engine Crankshafts." LFM (9b)

Destructive Tests on Banded Pipes for High-Head Water-Power Scheme. G. Sirovich. *Engineering*, Vol. 137, Mar. 23, 1934, pages 360-361; Apr. 6, 1934, pages 397-399. Gives results of extensive tests carried out for the Société Anonyme La Dixence of Lausanne, Switzerland, to ascertain the suitability as to resilience, elongation and deformation of the steel for a large conduit supplied by Tubi Togni of Brescia, Italy. The information given here was taken from an article by the same author entitled "La condotta forzata per il plu' grande salto de mondo" in *Elettrotecnica*, Vol. 19, Aug. 15-25, 1932, pages 585-593. Numerous illustrations, graphs and tables are given. LFM (9b)

View from rear, showing control cabin

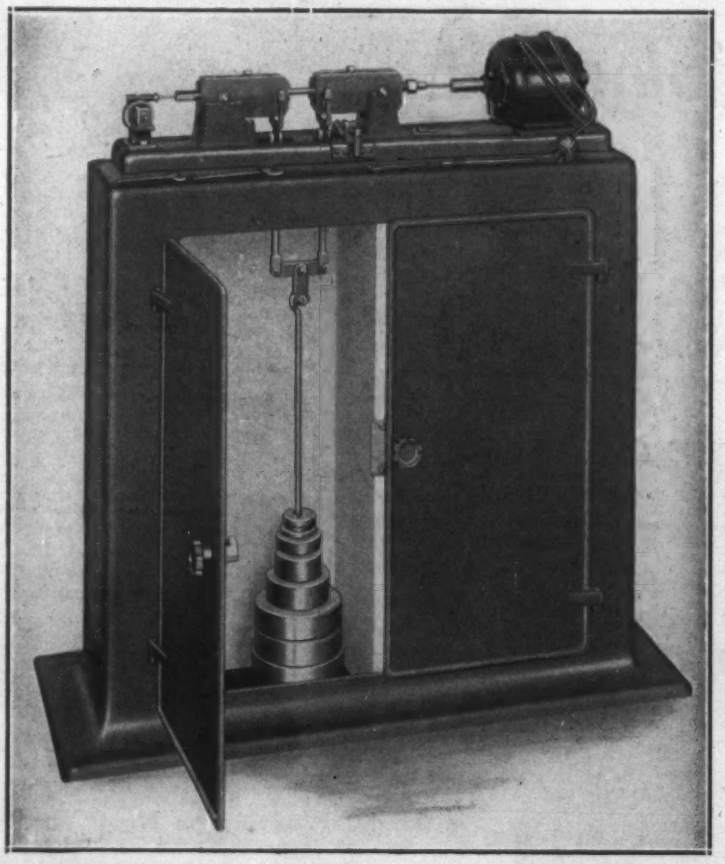
● At the Washington Navy Yard the x-ray inspection of massive, irregularly-shaped objects in various stages of construction, and located at many different points about the plant, presents a problem which is duplicated in other industries far removed from the outfitting of battleships. If yours is one of these industries, take a tip from Uncle Sam and investigate the possibilities of the G-E KXC-3 Mobile Shock-Proof X-Ray Unit, designed to meet U. S. Navy specifications for this class of service.

G-E KXC-3 is a self-contained shock-proof x-ray unit, operating at values up to 10 milliamperes at 220,000 volts peak, with an oil-immersed and oil-cooled XPT Coolidge x-ray tube in a shock-proof and x-ray-proof casing, so arranged that its x-ray output can be directed at practically any angle desired and within a large radius. The complete equipment is so compactly assembled on a trailer truck that it can readily be picked up by crane, if necessary.

Write for complete information regarding G-E x-ray units, designed for either general or specific industrial applications. Address Industrial Division.

GENERAL ELECTRIC X-RAY CORPORATION
2012 JACKSON BLVD. CHICAGO, ILLINOIS
Branches in Principal Cities

THE R. R. MOORE
FATIGUE TESTING
MACHINE



A thoroughly practical and reliable machine for determining the life of metals. Adaptable to various shapes and sizes of specimens.

• It has proven its value in the laboratories of scores of industrial corporations, governmental departments and universities.

WRITE FOR OUR PAMPHLET ON FATIGUE TESTING

THE THOMPSON GRINDER CO.
1534 WEST MAIN STREET SPRINGFIELD, OHIO

Detroit Representative:
STEEL CITY TESTING LABORATORIES
Detroit, Mich.

Fatigue Testing (9c)

H. F. MOORE, SECTION EDITOR

The abstracts appearing under this heading are prepared in co-operation with the A.S.T.M. Research Committee on Fatigue of Metals.

1 **Fatigue Testing Machines for Superimposed Alternating Loads of Tension, Compression and Shear (Dauerprüfmaschine für überlagerte Zug-, Druck-, und Schub-Wechselbeanspruchung).** E. LEHR & W. PRAGER. *Forschung (Zeitschrift Technische Mechanik und Thermodynamik)*, Vol. 4, Sept./Oct. 1933, pages 209-214. In order to study the law governing the alternating fatigue properties when oscillating normal and shear stresses superimpose each other or are superimposed with static stresses, authors developed a special fatigue testing machine. In this machine an alternating tension or compression load can be superimposed at random with an alternating shear load that has a synchronous course to the first one and the phase of which can be controlled. Simultaneously static initial stresses of tension, compression and shear can be applied. Furthermore tube-like test bars can be subjected to an internal superpressure while applying alternating loads. The oscillating longitudinal elongation can be measured by means of a special optical instrument the oscillating torsion by means of a mirror arrangement. GN (9c)

2 **Effect of Notches on Nitrided Steel.** J. B. JOHNSON & T. T. OBERG. *Metals & Alloys* Vol. 5, June 1934, pages 129-130. Results reported indicate that a hard case does not necessarily render material more susceptible to notch effect. Nitrided steel shows superior resistance to notch effect compared to oil hardening steels. WLC (9c)

3 **Influence of Corrosion on Fatigue Limit of Chromium-nickel Alloys (Der Einfluss der Korrosion auf die Dauerfestigkeit von Chromnickel-Legierungen).** A. THUM. Heraeus Vacuumschmelze. 10th Anniversary Volume, 1933, pages 424-434. Under corrosive conditions the fatigue limit of Cr-Ni steels is considerably lowered; whereas that of Ni-Cr alloys of the contracid type is hardly affected, since no intercrystalline penetration of the corrosive medium takes place. Contracid with 7% Mo and 0.65% Be has a fatigue limit of 25-28 kg./mm.² according to the heat-treatment to which it has been subjected. (9c)

4 **Alternating Torsion Tests on Magnesium Crystals (Über Wechseltorsions-Versuche mit Magnesiumkristallen).** E. SCHMID & G. SIEBEL. *Metallwirtschaft*, Vol. 13, May 18, 1934, pages 353-356. Test bars of 2 and 3 mm. diam. consisting of single crystals of Mg of various orientations were subjected to alternating torsion tests. The frequency was 200 reversals/min. and the torsion angle was varied. After 100 million cycles the test bars were broken in a static tensile test and subjected to microscopic and X-ray examination. In fatigue tests of Mg crystals the same types of deformation take place as in static tests, base translation and mechanical twin formation. The fatigue fractures are irregular and are formed by several planes. The base plane, $(10\bar{1}0)$ prism plane, and $(10\bar{1}1)$ and $(10\bar{1}2)$ pyramid planes were observed in fractures. The strength of the base plane increases considerably at first as the stress is increased, but falls off slightly with further increase. The degree of initial overstressing is influenced by crystal orientation and cross section. If the base plane is very oblique the crystals become very brittle in these tests as the number of cycles is increased. CEM (9c)

5 **Recent Metallurgical Progress (Les Derniers Progrès Métallurgiques).** E. MARCOTTE. *Arts-et-Métiers*, Vol. 85, Apr. 1934, pages 69-74. Article is chiefly devoted to description of the fatigue testing machine of the Service des Recherches de l'Aéronautique and of the universal Arthuis testing machine suitable for testing small test bars (tensile, Brinell hardness). Last section of the article deals with means of detecting effects of corrosion in metals and with effect of very low temperatures on properties of metals. FR (9c)

6 **The Strength of Screw Threads Under Repeated Tension.** H. F. MOORE & P. E. HENWOOD. *University of Illinois Bulletin*, Vol. 31, No. 28, March 13, 1934, Bulletin No. 264, Engineering Experiment Station, 17 pages. Price 25c. Endurance tests in repeated tension from zero to a maximum, compared a 0.30% carbon steel not heat-treated and having 37,000 lbs. endurance limit with a S. A. E. 2320 steel of 0.20% C and 3.25% Ni oil quenched from 1500° F. and drawn at 800° F. with an endurance limit of 73,000 lbs./in.². With a Whitworth thread both steels, tested as threaded studs showed practically the same endurance, about 22,500 lbs./in.² and the S-N curves closely coincided. With the sharper U. S. Std. thread the nickel steel was superior having 19,000 lbs./in.² against about 13,000 lbs./in.² endurance limit for the carbon steel, and the S-N curve shows the nickel steel to behave better at overstresses. Rolled threads were also studied on another 30% carbon steel with an endurance limit (for the steel) of 43,000 lbs./in.² and (for the stud) of 20,000 lbs./in.² More threads were under test in the case of the rolled than the die-cut threads which may have favored the rolled thread somewhat. The stress-concentration factors were figured and found to be about 3.8 for the nickel steel and 2.8 for the carbon steel with die-cut U. S. Standard threads, these actual values being much below the 5.6 figure indicated by photo-elastic test. As usual, the factor was found to be the higher for the harder steel. HWG (9c)

7 **Repeated Stress (fatigue) Testing Machines Used in the Materials Testing Laboratory of the University of Illinois.** H. F. MOORE & G. N. KROUSE. *University of Illinois Bulletin*, Vol. 21, No. 30, Mar. 27, 1934, Circular No. 23, Engineering Experiment Station, 36 pages. Price 40c. Description of a variety of types of fatigue testing machines, specimens and the stress distribution therein. Many of these have been designed in the Illinois laboratory, including a high speed machine which runs at 30,000 r.p.m. or 20 times as fast as the usual machine, and uses a small, cheaply machined specimen. Perhaps the most interesting feature of the pamphlet is a tabulation of endurance limits on structural steel, rail steel, 4130 heat-treated (to 92,000 lbs./in.² endurance limit), cast iron and duralumin, in slow speed rotating beam, high speed rotating beam, axial load, and repeated bending of flat specimens. The high speed machine gives endurance limits about 1000 lbs./in.² or so higher than the others on the average, but the axial load test checks with all the others, except for cast iron, whose behavior is probably due to sensitivity to essentricity of loading. Within reasonable engineering limits, it appears that any of the methods of testing will evaluate the endurance limit satisfactorily. The advantages and disadvantages of the different machines are discussed, as to convenience, first cost of machine, and cost of machining the specimen. HWG (9c)

8 **A Fatigue Testing Machine for the Determination of Fatigue Properties of Test Bars and Shapes (Eine Dauerprüfmaschine zur Bestimmung der Dauerhaltbarkeit von Proben und Formelementen).** H. OSCHATZ. *Metallwirtschaft*, Vol. 13, June 22, 1934, pages 443-448. A fatigue testing machine is described which can be used for repeated bending and torsional tests of standard test bars and shapes of various kinds used in the construction of machines. This is accomplished by means of universal grips. The effect of size and shape, notches, and surface condition on the fatigue properties can be investigated by use of this machine. It contains a device whereby the stress can be made a combination of static and dynamic forces and it can also be used for purely static torsion tests. It is equipped for tests at elevated and extremely low temperatures. CEM (9c)

9 **Duration Tests of Steels under Tensile-, Compression- and Bending Stresses.** TOSHIO NISHIHARA, TADAKAGU SAKURAI & TERUO WATANABE. *Journal of the Society of Mechanical Engineers*, Vol. 36, Oct. 1933, pages 673-681. (In Japanese.) Paper read before the 48th Meeting, Apr. 20, 1933. Experiments proving the difference in fatigue limit of steel when submitted to compression or tensile stresses. A notched bar shows greater fatigue resistance in bending tests if previously submitted to tensile stress. Kz (9c)

The Fatigue of Metals (Die Ermüdung der Metalle). A. LOEBNER. *Die Giesserei*, Vol. 21, June 8, 1934, pages 248-249. The nature of "fatigue" of metals is explained and shown that this phenomenon can not be taken into account by the usual (static) mechanical tests with a safety factor but that dynamic testing methods have to be applied to ascertain the admissible stresses from alternating bending tests. Ha (9c)

Magnetic Testing (9d)

L. REID, SECTION EDITOR

Investigation of Weld Seams by Electro-Magnetic Methods (Über die Untersuchung von Schweissnähten auf elektromagnetischen Wege). MAX WOLF. *Die Elektroschweissung*, Vol. 5, Apr. 1934, pages 71-75. Author describes electro-magnetic testing methods of weld seams developed by Institut für elektrische Maschinen of Technische Hochschule Braunschweig. The general principles of magnetic testing methods, change of cross-section in magnetic circuit, determination of best induction, course of induction lines in air near a defect and magnetic screening were first investigated in theory and by experiment. A d.c. testing apparatus for investigation of weld seams is described and results of experiments given. Furthermore a second instrument working on the new method of current flow is described. The latter instrument makes possible measurement of the magnetic air field originating from currents in the test piece that are deflected by defects. By a unique arrangement of the testing coil all other air fields are made ineffective. In this method a.c. is applied; however, it can also be measured ballistically. Results of practical measurements on a 5 mm. thick steel plate injured by a saw cut are given. The apparatus described is fit for measurements on butt welds only but can be adapted to flank seams by giving magnetic poles a special shape. GN (9d)

Mechanical Hardness, Influenced by Magnetism and Measured by Magnetostrictive Effects. S. R. WILLIAMS. *Transactions American Society for Steel Treating*, Vol. 21, Aug. 1933, pages 741-768. It is found that changes in length of ferromagnetic rods when magnetized longitudinally had a relation to mechanical hardness. Studies of the possibility of hardness measurement by magnetostrictive measurements are reporfed. Magnetization process itself changes hardness, first effect is to reduce hardness. See also *Metals & Alloys*, Vol. 4, Nov. 1933, page MA 350. WLC (9d)

Electromagnetic Testing of Weld Seams (Elektromagnetische Schweissnaht Prüfung). FRANZ UNGER. *Die Elektroschweissung*, Vol. 4, Oct. 1933, pages 192-194. Method and apparatus for electromagnetically testing weld seams are described. Tests were made with a.c. and d.c. magnetization. In first case stationary testing coils are applied, in latter case coils must be kept in motion permanently. A magnetizing coil is arranged above work piece. A voltage is induced in the test coil at locations of poor magnetic properties. This voltage is indicated or made audible. Defects of small extension vertical to seam cause but small changes of magnetic field, i.e., are indicated but faintly. The same holds true for small longitudinal defects. Change of field strength at a defect is larger the greater the magnetic field strength in Fe and the larger the change of magnetic permeability with Fe induction. Large changes of permeability at small field strength (initial permeability) gives so small values of changes in air gap that voltages induced in testing coil require high amplification. In ingot Fe highest sensitivity of testing coil is attained at inductions of about 15,000 gauss. Therefore, relatively large electromagnets are required for thick sheets. Magnetic flux must be kept constant for only then measurements permit safe conclusion on size of defect. Depth of defect has no essential effect on sensitivity of indicating instrument. Order of magnitude of defect which is accurately indicated depends not only on its shape (round defects are indicated best) but also on smoothness of weld seam. GN (9d)

Testing of Materials and Welds without Destruction with Particular Consideration of Magnetic Methods (Zerstörungsfreie Werkstoff-und Schweissnahtprüfung unter besonderer Berücksichtigung magnetischer Verfahren). J. PFAFFENBERGER. *Oberflächentechnik*, Vol. 11, Apr. 3, 1934, pages 80-81. Testing of materials by X-rays, advantages and disadvantages are explained. While this method is rather expensive and results are obtained mostly only after a picture has been developed, magnetic testing gives immediate results. The relation between magnetic induction and defects are explained and various methods, as change of induction, use of iron filings, acoustic methods, are discussed. Ha (9d)

The magnaflux Test for Discontinuities in Steel. A. V. DE FOREST. *Preprint Mid-Year Meeting, American Petroleum Institute, Production Division.* May 1934, 6 pages. When the magnetic flux in a substantially uniform field is interrupted by a sudden discontinuity, a small magnetic pole forms a leakage field over the defect. This field can be detected by its ability to attract finely divided iron particles. Surface defects, longitudinal segregations, fatigue cracks, etc., can be detected in this way. Illustrations and applications are given. VVK (9d)

Promotion of Welding Technique in the Petroleum Industry by Practical Testing of Welds (Die Förderung der Schweisstechnik in der Erdölindustrie durch betriebsbrauchbare Schweissnahtprüfung). S. KIESSKALT. *Montanistische Rundschau*, Vol. 26, May 16, 1934 (Section *Stahlbau-Technik*) pages 3-4. Describes a portable apparatus developed by Schweitzer and Kiesskalt for testing welds by electromagnetic induction. BHS (9d)

Magnetic Test Locates Flaws in Valve Springs. ALFRED V. DEFOREST. *Mechanical World & Engineering Record*, Vol. 92, Aug. 12, 1932, pages 145-146. See *Metals & Alloys*, Vol. 5, May 1934, page MA 212. Kz (9d)

Spectrography (9e)

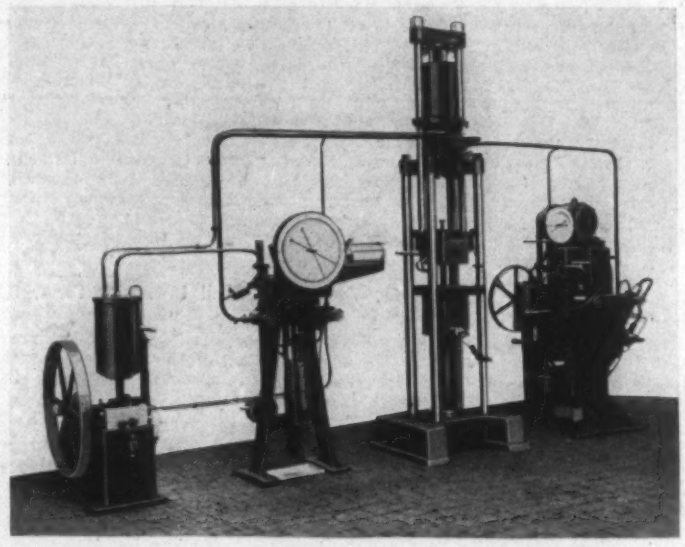
Use of the Photo-electric Cell in Spectography (Die Verwendung der Sperr-Schichtphotozelle in der Spektrographie). W. KROLL. *Metall und Erz*, Vol 31, Mar. 1934, pages 105-107. In quantitative spectrographic analysis using the spark there are apt to be errors due to variations in light intensity. This may be caused by the spark wandering around the sample, oxides forming on the sample which reduce the spark intensity temporarily, or the spark may burn into the sample, as in the case of Pb. To correct for these variations a Se photo-electric cell is placed directly in front and below the slit of the spectrograph. The light intensity is registered on a galvanometer and the exposure time is shortened or lengthened to correct for the intensity. The use of the photo-electric cell is limited on account of its wave length selectivity. It cannot be used for carbon arc determinations. CEM (9e)

Spectralanalysis by Means of Sensitive Lines Lying in the Range of Optical Glasses (Beiträge zur Spektralanalyse mit Hilfe in der Glassoptik zugänglichem Gebiet biegender empfindlicher Linien). WILHELM KRAEMER. *Zeitschrift für analytische Chemie*, Vol. 97, No. 3/4, 1934, pages 89-93. See *Metals & Alloys*, Vol. 4, June 1933, page MA 189. Ha (9e)

X-ray Spectroscopy and Imaging by Means of Curved Crystal Reflectors (Röntgenspektroskopie und Abbildung mittels gekrümmter Kristallreflektoren. G. ISING. *Arkiv för Matematik, Astronomi och Fysik.* Vol. 23 B, No. 5, Oct. 10, 1933, 2 pages. The author designed a Gouy spectrograph incorporating bent mica. A photogram of Zn obtained in coöperation with Phragmen is reproduced. Exposure time = 3 min. Current intensity = 4.5 mm. amps. load = 90 k. volts, width of apeture = .08 mm. EF (9e)

AMSLER

Universal Testing Machine



Capacity:

a. in standard, static tests . . 60,000 lbs.

b. in fatigue tests (up to 500 stress-cycles per min.) . . 30,000 lbs.

The time is approaching when it will be *universally* recognized that we must determine the strength properties of metals and alloys not only by applying static loads, but also by exposing them to *rapidly pulsating* stresses, at normal and elevated temperatures.

The time is coming when such repeated-stress tests, using *full-size* bars and complete structural sections, will be performed as part of *routine* test procedure, in accordance with specifications which will be "standard" in all countries.

When that time arrives, it will be realized that of the universal testing machines in general use, *only* the "Amsler" is fully suitable for such test requirements.

Write for Leaflet No. 200

HERMAN A. HOLZ

Complete Line of Amsler Universal Testing Machines, Constructed for Static and Rapidly-Repeated-Stress Applications, or Equipped for Static Tests and Fully Prepared for Later Addition of Pulsating Equipment.

167 East 33rd Street New York, N. Y.

METALLOGRAPHY (10)

J. S. MARSH, SECTION EDITOR

System Copper-Lead-Sulphur (Beitrage zur Kenntnis des Systems Kupfer-Blei-Schwefel). W. GUERTLER & G. LANDAU. *Metall und Erz*, Vol. 31, Apr. 1934, pages 169-179. To study the Pb-PbS system 21 alloys were made by melting Pb in an electric furnace, holding at constant temperatures while H_2S was passed over the surface, and then cooling. All alloys consisted of a mixture of Pb and PbS with considerable segregation. The PbS content increased as the treating temperature was raised. In samples treated at lower temperatures, PbS was found only at the top. The results of analysis and metallographic examination agree with those of Friedrich and Leroux. 51 Cu-Pb-S alloys were prepared by melting Cu_2S, PbS, Cu and Pb in an electric furnace in an atmosphere of CO, and cooling slowly in the furnace or quickly in air and then quenching in water. Chemical and thermal analysis and microscopic examination were made of different layers of the samples and a constitutional diagram was constructed. The photomicrographs of several alloys near the quasi-binary Pb-Cu_2S composition show a middle layer consisting of a little Cu_2S in Pb between the upper and lower layers. In slowly cooled samples this layer occurs at a higher level than in quickly cooled samples. It is formed by the reaction at the junction of PbS from the eutectic of the upper layer with Cu from the lower layer during cooling between 942° and 600° C. In the alloys containing 41-58% Cu, 35-58% Pb and .33-7% S the thermal effects were observed which had been expected theoretically for 3 layer formation, but the 3 layers were not actually formed .The densities of the constituents of the ternary alloys compared with those of the binary Pb-Cu alloys shows that only small S additions are sufficient to greatly reduce the difference in density. By adding small amounts of S, .67 to 1.6%, to Cu-Pb bearing metals, these 2 layer alloys can be converted into practically single-layer alloys. 32 references. CEM (10)

The Chemistry of Solids. CECIL H. DESCH. Cornell University Press, Ithaca, 1934. Cloth, 6 x 9¼ inches, 213 pages. Price $2.50.

The title covers a lot of ground; the author admits that certain important branches of the subject are omitted. The major portion of the book deals with live topics taken from the field of metallography. With numerous references to the literature the present state of knowledge is clearly presented.

The following topics will be of special interest to the metallurgist: the crystal boundary, etch-figures, surface films, corrosion-fatigue, diffusion in solids, the Widmannstätten structure, the martensitic structure, and age-hardening. Recent facts and theories relating to the mosaic structure of crystals are given in a very comprehensible form. While admitting that the vitreous phase hypothesis of Beilby is now out of favor, the author presents a case for it that deserves serious consideration.

While originally prepared as a series of lectures the book is free from the peculiarities of style common to material for oral presentation. It forms instructive and stimulating reading. While not exhaustive enough to merit being called a "reference book," it is not to be read once and forgotten. H. W. Russell (10)—B—

Gmelins Handbook of Inorganic Chemistry—Iron (Gmelins Handbuch der anorganischen Chemie-Eisen). 8th Edition. Verlag Chemie, Berlin, 1934. Paper 7 x 10¼ inches, Part A, Section 6, pages 1167-1420; Section 7, pages 1421-1634. Price, unbound, Section 6, 41.5 RM. Section 7, 36 RM.

Ten collaborators prepared section 6; section 7 was prepared by O. von Auwers. Section 6 covers the systems Fe-S, Fe-Se, Fe-Te, Fe-B, Fe-C, heat-treatment and structure of carbon steels, case hardening and nitride hardening, with literature references up to January 1, 1934. Section 7 deals with magnetic and electrical properties, with references up to June 1, 1934.

As in previous sections, these sections are primarily very extensive bibliographies with a small amount of text in staccato phraseology and much of the essential information given in figures, of which the two sections contain some 250. As a finding list to the literature, they are of distinct value.

The text is useful, but is less connected, and less informative, in general, than Mellor, to which this may be classed as the German counterpart.
H. W. Gillett (10)—B—

Preparation of Lead and Lead Alloys for Microscopic Examination. BRINLEY JONES. *Engineering*, Vol. 136, Oct. 20, 1933, page 449. See *Metals & Alloys*, Vol. 5, May 1934, page MA 184. LFM (10)

Sub-Structures in Ferrite. W. D. JONES. *Metallurgist*, Supplement to *The Engineer*, Feb. 24, 1933, pages 8-11. Critical review of recent literature. VVK (10)

A Microscopic Examination of Iron-tin Reaction Products. W. D. JONES & W. E. HOARE. *Iron & Steel Institute*, Advance copy No. 10, May 1934, 8 pages. Sn was sealed in Fe "bombs," heated to different temperatures for 5 hr., cooled, and the resulting layers of Fe-Sn alloy examined microscopically. This method failed to yield sufficient information in regard to some points of the Fe-Sn diagram. Alloys were then prepared by making a pile of foil disks, clamping the pack of disks, and heating to the desired temperature for a time necessary to produce substantial equilibrium between the alloy phases. Sn foil of different thickness was used to obtain desired compositions. Three intermetallic compounds are formed in the Fe-Sn system—Fe_2Sn, FeSn, and $FeSn_2$. The γ phase of Ehret and Westgren was not found. Sufficient data are not available for the construction of a reliable diagram. 6 references. JLG (10)

An X-ray Analysis of the Crystal Structure of the Thallium-tin Alloys. H. J. C. IRETON, J. P. BLEWETT & J. F. ALLEN. *Canadian Journal of Research*, Vol. 9, Nov. 1933, pages 415-418. Article illustrated by a series of x-ray diffraction spectrograms, and dealing with the crystal structure of thallium-tin alloys. The tin lattice constant had a maximum value at the eutectic point (42.5% Tl). The superconducting curve showed a cusp-shaped minimum at this point and a peak at the solubility boundary. The addition of Sn to Tl resulted in a change from α to β Tl similar to that already noted in other Tl alloys. OWE (10)

The "Single-crystal" State of Metals. H. C. H. CARPENTER. *Bulletin Institution of Mining & Metallurgy*, No. 357 June 1934, pages 13-34. The production of single crystals from the vapor phase, liquid phase, or solid phase, the orientation of crystals in single-crystal test pieces, and the properties of single-crystal metals are discussed. The mechanical properties of single-metal crystals are usually directional. AHE (10)

The Structure of the Alloys of Gold and Copper (Sur la structure des alliages or-cuivre). W. BRONIEWSKI & K. WESOLOWSKI. *Comptes Rendus*, Vol. 198, Jan. 22, 1934, pages 370-372. Broniewski and Wesolowski describe tests made on alloys prepared in a graphite crucible in a high-frequency furnace and subsequently homogenized by annealing at 800° C. for 50 hours. After drawing into wires of 5mm. diameter, the alloys were heated at 650° C. for 1 hour and then either quenched in water or cooled, with a prolonged rest at 300° C., for 50 hours. The article is accompanied by 2 figures showing (1) an equilibrium diagram, (2) an electric conductivity (0°C.) curve, (3) a temperature coefficient of electric resistance (0-100° C.) curve, (4) thermoelectric power (—80 and —100° C.) curves, and (5) dilatation curves for the system. The existence is confirmed of 2 compounds, AuCu and $AuCu_3$, soluble in the solid metallic components of the system. No evidence was obtained to support the view that a compound Au_2Cu_3 existed, either in the labile or in the stable state. OWE (10)

1 **Existence of Three Allotropes of Calcium (Sur l'existence de trois variétes allotropiques du calcium).** P. BASTIEN. *Comptes Rendus*, Vol. 198, Feb. 26, 1934, pages 831-833. Operating in an atmosphere of argon, and using a relatively large quantity (2 kg.) or sublimated Ca, B has obtained differential cooling, differential thermoelectric power, and dilatation, curves which indicate the existence of at least 3 allotropic forms of this metal, one existing from 0° C. (and possibly lower) to 260° C., another from 260° C. to 430-440° C., and yet another from 430-440° C. to the melting point. OWE (10)

2 **Constitution of the Magnesium-zinc-silicon System (Sur la constitution des alliages magnesium-zinc-silicium riches en magnesium).** E. ELCHARDUS & P. LAFFITTE. *Comptes Rendus*, Vol. 197, Nov. 13, 1933, pages 1125-1127. Article describes results of work on this system, which has served to confirm the absence of a ternary compound and upon which 2 ternary diagrams which illustrate the article are based. The one shows the limit of miscibility of the liquid phases, the other the constituents shown by microexamination to exist in the alloys at room temperature. A ternary eutectic containing 53.3% Mg, 43.5% Zn, and 3.2% Si, melting at 335° C., was found. The limit of the ternary solid solution was approximately 94.5% Mg, 5.25% Zn, and 0.25% Si. OWE (10)

3 **Occurrences on Tempering Quenched Steel (Die Vorgänge beim Anlassen abgeschreckter Stähle).** H. ESSER & H. CORNELIUS. *Archiv für das Eisenhüttenwesen*, Vol. 7, June 1934, pages 693-697. Carbonyl Fe-C alloys with 0.3 to 1.8% C were water quenched and tempered, the tempering effects being studied by a differential-thermal-analysis method and by hardness tests. Three tempering stages were observed (1) at 100-150° C., the change from tetragonal to cubic martensite (2) at 280° C., the decomposition of retained austenite (3) at the same and slightly higher temperatures, the formation of distinct cementite particles from the precipitated Fe_3C molecules. The hardness tests indicated that most austenite is retained at the critical cooling velocity just above that at which some troostite would form; above and below this critical cooling velocity there is less retained austenite. SE (10)

4 **A New Magnetic Phenomenon: Increasing Paramagnetism Superimposed on Diamagnetism in Alloys with a False Curie Point (Sur un Nouveau Phénomène Magnétique: le Paramagnétisme Croissant Superposé au Diamagnétisme dans les Alliages à Faux Point de Curie).** ROBERT FORRER & A. SERRES. *Comptes Rendus*, Vol. 198, May 28, 1934, pages 1903-1905. Alloys with false Curie point have no magnetic moment but show same thermal anomalies as ferromagnetic alloys. However, the crystalline structure is the same above and below the false Curie point. Alloys studied were beta brass, Cu-Zn, gamma brass, Cu_5Zn_8, Ag-Zn and Cu-Sn. Below temperature of false Curie point, diamagnetism is a constant but above it diamagnetism decreases almost linearly with the temperature. FHC (10)

5 **Transformations of the β-Phase of Cu Al Alloys. Preliminary Report. (Über die Umwandlungen der β-Phase der Cu-Al-Legierungen).** E. KAMINSKY, G. KURDJUMOW & W. NEUMARX. *Metallwirtschaft*, Vol. 13, May 25, 1934. page 373. Cooling curves were obtained on the eutectic alloy containing 12% Al. The β to $\alpha + \gamma$ transformation could be easily suppressed, slow cooling yielding β^1. Two distinct effects on cooling were observed at 500° and 380°C. The heating curves showed an indistinct effect at 450° and a distinct effect at 525°. If the sample was held for several min. at 450° during cooling the second cooling effect was lowered to 250° and the first heating effect lowered to 360°. Longer holding at 450° resulted in a change to $\alpha + \gamma$. After this change, the cooling curves showed no further effects. These observations are in full accord with the recent results of Wassermann. The reversible transformations β to β_1 and β_1 to β^1 occur very rapidly and could be suppressed by quenching. They both take place without diffusion. CEM (10)

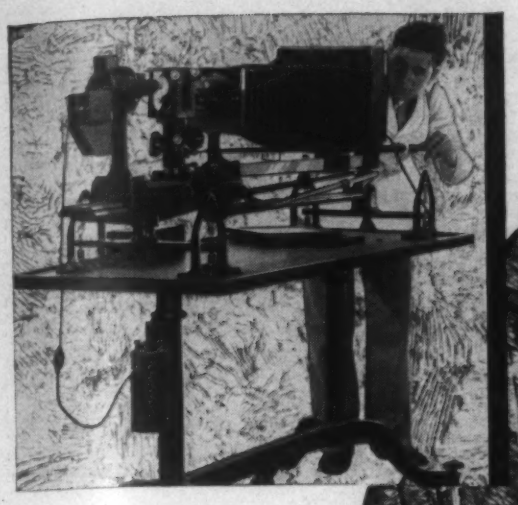
6 **Study of constitution by magnetic methods. Part II. Ferromagnetic measurements (Konstitutionsforschung mit magnetischen Verfahren. Teil II. Ferromagnetische Messungen).** A. KUSSMANN. *Zeitschrift für Metallkunde*, Vol. 26, Feb. 1934, pages 25-33. The use of magnetic methods in the study of constitution is usually limited to determinations of (a) saturation magnetization, (b) Curie point, (c) coercive force. The primary properties (a) and (b) are determined only by the chemical constitution (the atomic structure), while the secondary properties like (c) are determined only by intercrystalline strains and are thus influenced by structure. (a) and (b) are independent of crystalline anisotropy, grain size, structural distribution of constituents, strain and cold work, but depend upon the quantity and constitution of phases present. Solid solutions with a ferromagnetic metal as solvent are ferromagnetic, (a) and (b) decreasing ordinarily more greatly than demanded by the rule of mixtures (a) is additive in heterogeneous fields and (b) unchanging. Discontinuous changes in (a) and (b) are formed with discontinuous changes in constitution. (c) changes little in a solid solution field, and in a heterogenous field is usually higher than required by the rule of mixtures owing to strains. (c) is determined by the state of strain which is influenced by the form and quantity of structural constituents, their distribution, and their difference in thermal expansion. Methods of making the necessary measurements are described. The dependence of (b) upon concentration in solid solution fields may be used to determine the extent of such a field; similarly the linear course of (b) in a heterogeneous field may be used to determine the extent of this. (a) may be used similarly. The unimportance of specimen size and shape offers obvious conveniences, not afforded by other methods of investigation. Solid solubility curves may be determined by simple quenching experiments in this way. Temperature-saturation magnetization curves may be used to follow changes in constitution; this has proved useful in studying the decomposition of austenite and martensite. (c) is affected chiefly by strains lying between atomic and intercrystalline and but little by macro-strains such as Heyn strains. Thus (c) is increased by all varieties of cold work; this decrease is removed by strain-relief anneal; the characteristics of stress-strain curves are paralleled by magnetic characteristics. The sensitivity of (c) towards internal strains permits a determination of the presence of very small amounts of an undissolved phase where other methods fail. Solid solutions are generally characterized by low coercive force and low hysteresis loss, and heterogeneous mixtures by high coercive force and high hysteresis loss. The smaller the particle size on precipitation from solid solution, the higher the coercive force; higher temperatures of precipitation exert some annealing effect and lower the coercive force. Special applications of the general methods described are given. RFM (10)

7

8

9

10 **An Intermediate Phase in Hypereutectoid Copper-Aluminum Alloys. Preliminary Report (Über eine Zwischenphase in den übereutektoidischen Cu-Al-Legierungen).** G. KURDJUMOW & T. STELLETZKY. *Metallwirtschaft*, Vol. 13, Apr. 27, 1934, page 304. When Cu-Al alloys containing 13.5 to 15% Al are quenched from above the eutectoid temperature a new phase, tentatively designated γ^1 is formed, corresponding to the β^1 of alloys containing 12.5% Al. When quenched from the temperature of the homogeneous β phase γ^1 only is formed. Quenching at 800° C. and above forms γ and γ^1 and quenching from between the eutectoid temperature and 670° forms γ and β^1. Quenching from the intermediate temperatures forms γ, β^1 and γ^1. The γ crystals are parallel to the β mother crystals according to examination of single crystals, and repeated heat treating does not change their orientation. Pole figures were constructed for the γ^1 crystals, but the type of lattice has not yet been determined. Their microstructure is different from the β^1 phase, having no needles. Contrary to the β, phase, the formation of γ^1 requires a fairly high cooling velocity. Apparently γ^1 forms at less than 300°. The γ^1 phase may be a γ phase supersaturated with Cu. CEM (10)



This Photomicrograph, made with B & L 5.5mm objective, negative eyepiece and regular illuminating system, is reduced from 7½ in. It is unmasked!

OPTICS for your particular work—

Every metallographer who has made photomicrographs at 500X magnifications has encountered serious difficulty in obtaining both resolution and flat field. Those who are using the B & L 5.5mm objective and negative eyepiece, however, have *entirely* eliminated that trouble.

These B & L Optics are designed specifically to produce flat field at 500X magnifications.

For other magnifications the well known flat field Ampliplan eyepieces give equally excellent results — results obtainable only with optics especially designed for your particular problem.

Bausch & Lomb's knowledge of your requirements is further evidenced in the large metallographic equipment by its permanent alignment and vibrationless features. With this adaptable equipment many other special optics may be used, such as —

Ultra violet optics	— For resolution with short wavelengths.
Apochromatic objectives Fluorite objectives	— For excellent resolution.
Compensating eyepieces	— For use with Apochromatic objectives.
Hyperplane eyepieces	— For flat field with Achromatic objectives (visual).
Micrometer eyepieces	— For grain size measurements.
Micro Tessars	— Unexcelled for Macro photography.
Tessars	— For gross photography.

Bausch & Lomb invites you to consult them regarding the best optics for your particular work. Write to Bausch & Lomb Optical Co., 634 St. Paul Street, Rochester, New York.

Bausch & Lomb

OPTICAL INSTRUMENTS FOR THE INDUSTRIES

The Hydrogen Permeability of Armco Iron and Iron of Different Carbon Contents at Temperatures from 700° to 1000° C. (Über die Wasserstoffdurchlässigkeit von Armco-Eisen und Eisen mit verschiedenen Kohlenstoffgehalten bei Temperaturen von 700 bis 1000). G. Lewkonja & W. Baukloh. *Zeitschrift für Metallkunde*, Vol. 25, Dec. 1933, pages 309-310. Steel sheets from top, the middle of the top half, and the middle of an ingot containing a large amount of inclusions heated 30 hrs. in H at 1000° showed blisters on subsequent rolling owing to included H, whereas sheet not treated with H showed no blisters. The rate of diffusion of H through the walls of a bored-out round bar of Armco iron was determined, under a pressure gradient of 1 atm. The results are shown in a graph, with cm.³/hr. plotted against temperature, from 700-1000° C., for wall thicknesses between 1 and 5 mm. These curves are nearly linear (except as noted below), running from zero at 720° to 16 cm.³/hr. at 100 for 1 mm. thickness, and from zero at 820° to 3.2 cm.³/hr. for 5 mm. thickness. No permeability was found in the vicinity of the A_3 point, owing to the impermanence of grain boundaries where diffusion is greatest. The rate of diffusion is shown on a graph to vary greatly with grain size. The dependence of amount of diffused H upon wall thickness is hyperbolic. The data of diffusion of H through simple carbon steels is fundamentally different owing to the superimposition of the decarburization reaction upon the diffusion process. Where the diffusion of H through Armco iron begins immediately, no diffusion is noted through steel between 0.095 and 1.025% C (at 850°, 5 mm. wall thickness) until after one to two hrs., during which time decarburization is taking place. Steel heated in ferroaluminum and thus possessing an Al-alloy outer layer decreases H diffusion; at 850° no diffusion could be detected when the alloy layer was 0.5 mm. thick. RFM (10)

Colloid Solutions in Metals (Kolloide Lösungen in Metallen). E. Podszus. *Kolloid Zeitschrift*, Vol. 62, Mar. 1933, pages 346-347. Only a few colloid solutions in the solid metal phase are known; e.g., refinable Al alloys, some structures of Fe-C compounds, and thoria in W. A method is briefly reported for obtaining as uniform a dispersion as possible of a colloidal solution in a metal by uniform adsorption of all ions at the boundary surfaces. The procedure is illustrated for the case of a colloidal solution of a thoria in finely powdered W metal or tungstic acid. Ha (10)

Precipitation Hardening in Iron-Chromium-Molybdenum and Iron-Chromium-Tungsten Alloys (Ausscheidungshärtung bei Eisen-Chrom-Molydän- und Eisen-Chrom-Wolfram Legierungen). E. Scheil, K. Bischoff & E. H. Schulz. *Archiv für das Eisenhüttenwesen*, Vol. 7, May 1934, pages 637-640. Addition of Cr to Fe-Mo alloys did not greatly modify the course of the solubility curve of the field $\alpha + Fe_2MO_2$ in which precipitation hardening can occur. The Cr raised the hardness obtainable by precipitation as much as 100 to 150 Brinell but because the alloys were coarse grained and brittle they were not tried out as cutting tools. Analogous results were obtained with the addition of Cr to Fe-W alloys, except that the maximum hardness obtained was lower for the Fe-Cr-W alloys. The magnetic properties of none of the alloys showed promise for permanent magnets. Resistance to scaling was good with low Mo and high Cr; increasing the Mo resulted in volatilization of Mo and lowered resistance to scaling. SE (10)

Alloys of Iron, Manganese and Carbon. Part V. Microscopic Studies of Binary Iron-Manganese Alloys. V. N. Krivobok & Cyril Wells. *Transactions American Society for Steel Treating*, Vol. 21, Sept. 1933, pages 807-820. Metallographic study is reported of Fe-Mn alloys covering entire range from pure Fe to pure manganese. 20 micrographs show that Fe-Mn system does not form a continuous series of solid solutions but contains several phases all of which have not been distinguished microscopically. WLC (10)

Ternary-phosphide Eutectic in Cast Iron as Shown by a New Etching Method (Das ternäre Phosphideutektikum im Gusseisen nach neuer Aetzung). M. Kuenkele & W. Heike. *Die Giesserei*, Vol. 21, Mar. 16, 1934, pages 119-122. A controversy over a paper by Heike and Gerlach (*Giesserei*, Vol. 21, Dec. 22, 1933, pages 561-563) with respect to formation of graphite in cast iron and the new etching agent. While Kuenkele maintains that the dissolved C in the ternary melt crystallizes immediately from the melt as graphite and does not come from disintegration of cementite, Heike is of the opinion that graphite is formed secondarily, for instance by disintegration of carbide, and supports this view with explanations of other investigators and micrographs. The action of the etching agent is cited as strongly supporting the latter theories, namely that graphite originates in solid cementite and that the latter disintegrates with very great velocity. Ha (10)

Thermomagnetic Study of the Heterogeneity of Iron-nickel-carbon-chromium Austenite Following the Precipitation of Carbide, Caused by Tempering (Etude thermomagnètique de l' hétérogénéité d'une austènite fer-nickel-carbone-chrome consécutive à la précipitation de carbure, par l' effet due revenu). Pierre Chevenard. *Comptes Rendus*, Vol. 198, Mar. 19, 1934, pages 1144-1148. Chevenard discusses the method which he has devised for studying the metastability of austenite in stainless steels and deals in particular with magnetization-temperature curves of an alloy containing 0.5% carbon, 37% nickel, and 10% chromium, which was quenched in water at 1200° C. and drawn at 850° C. for varying times. Four of these curves are reproduced and discussed. They were traced by a thermomagnetic recorder with a single mirror and owing to their sharpness were susceptible to graphic elaboration. In order to obtain quantitative expressions of the heterogeneity resulting from drawing of such steels as the above at varying temperatures, C. superimposes the magnetization temperature curve for the material in the stable condition (i.e., for material in which the carbides have been completely precipitated) upon the magnetization temperature curves for the material in a metastable condition. By comparing these curves, he obtains 3 points—(1) the Curie point Θ_1, which indicates the progress of the impoverishment in chromium and carbon of the austenite adjacent to the carbide grains; (2) the highest Curie point or rather that which is most readily measured, Θ_2 where the magnetization reaches a given small arbitrary value (this temperature allows of the approximate determination of the composition of the layers of austenite adjacent to the carbide grains); (3) the area σ contained between the pairs of curves, the value of σ being related to the volume of the alloy affected by heterogeneity. C.'s method has enabled him to determine for several alloys how the appearance, the intensity, and the disappearance of heterogeneity are related to the quenching temperature, the drawing temperature, the initial condition, etc. of alloys. In a second figure he shows the variation in the three factors, Θ_1, Θ_2, and σ in relation to the time of drawing at 850° C. C. has observed that cold-working subsequent to quenching lowers by more than 100° C. the temperature at which heterogeneity makes its appearance—i.e., at which carbide starts to precipitate from the austenite. Other things being equal, the rates of appearance and disappearance double for every increase of temperature of 15° C. It has also been found that the beginning of hardening coincides exactly with the appearance of heterogeneity and precedes quite definitely the precipitation of carbide visible under the microscope. OWE (10)

Alloys of Magnesium Research. Part I.—The Constitution of the Magnesium-rich Alloys of Magnesium and Nickel. John L. Haughton & Ronald J. M. Payne. *Journal Institute of Metals*, Vol. 54, 1934, 9 pages (Advance Copy No. 663). The diagram for alloys containing up to 50% Ni was determined by thermal and microscopic methods. Mg 99.97% pure was prepared by 3-fold sublimation. Its melting point was 649° C. ± 0.5° C. Mg forms a eutectic with the compound Mg_2Ni. The eutectic temperature is 507° C. and the composition is 23.5% Ni. The solid solubility of Ni in Mg is less than 0.1%. Some of the high-Ni alloys contained as much as 0.5% Fe, but a study of alloys containing less Fe showed that small amounts of Fe had little influence on the liquidus. JLG (10)

Transformation of β Aluminum Bronze (Über die Umwandlungsvorgänge in β Aluminiumbronze). G. Wassermann. *Metallwirtschaft*, Vol. 13, Feb. 23, 1934, pages 133-139. Samples prepared from electrolytic Cu and the purest obtainable Al, containing 11.9% and 12.7% Al, were homogenized at 900°-1000° C. for 4 days and quenched. The lattice structure was examined by X-rays between 580° and 750° and at various temperatures after several heat treatments. It was found that the β phase which exists in Al bronze above 570° is body-centered cubic with irregular atom arrangement. If cooled slowly the β phase is transformed into stable α + δ. If cooled rapidly the alloy consists at room temperature of the β^1 phase which is face-centered cubic similar to α. The β^1 phase is not stable, but persists up to 300°. If heated above 300° it is transformed into β_1, equivalent to Cu_3Al. When cooled again it returns to the β^1 phase, but when heated much above 300° it changes to the stable α + δ. When the β phase is quenched, it passes through the β_1 state between 570° and 350° before forming B^1. All the transformations occur through the formation and growth of nuclei, except the β_1-β^1 transformation, which is caused by mechanical slip in the lattice. In the β-β_1. β-δ and B_1-δ transformations the orientation and size of the crystals remains the same in general, as these three phases have similar structures. During the β-δ and β_1-δ changes the α phase is also formed with regular orientation. The δ + α phase can also be produced through the formation of a eutectoid and in this case the orientation between the phases is lost. However this is not the normal form of the β to δ + α transformation. 22 references. CEM (10)

Alloys of Iron and Manganese—Part XI. The Variation of Electrical Resistance with Temperature in Binary Alloys of Iron and Manganese. F. M. Walters, Jr. & Cyril Wells. *Transactions American Society for Steel Treating*, Vol. 21, Nov. 1933, pages 1021-1027. Electric resistance of Fe-Mn alloys, 0-29% Mn. was measured at temperatures 25°-1000° C. Mn greatly increases the resistance and decreases the temperature coefficient of alpha Fe. The resistance of gamma Fe is almost independent of the Mn at 1000° C. WLC (10)

Alloys of Iron and Manganese—Part X. Thermomagnetic Analysis of the Binary Alloys of Iron and Manganese. F. M. Walters, Jr. & John F. Eckel. *Transactions American Society for Steel Treating*, Vol. 21, Nov. 1933, pages 1016-1020. Effect of Mn on ferrite is to decrease its magnetism moderately. Alloys of over 16% Mn are practically non-magnetic, being composed of gamma and epsilon phases, which are non-magnetic. WLC (10)

The Electron Microscope (Das Elektronenmikroskop). A. Stäger. *Technische Blätter der deutschen Bergwerkszeitung*, Vol. 24, Apr. 15, 1934, pages 223-224. Principles underlying the electron microscope and construction developed by the research institute of Allgemeine Elektrizitätsgesellschaft, Berlin. GN (10)

System Fe-Fe_3C-ZrC-Fe_3Zr_2 (Das System Fe-Fe_3C-ZrC-Fe_3Zr_2). R. Vogel & K. Löhberg. *Archiv für das Eisenhüttenwesen*, Vol. 7, Feb. 1934, pages 473-478. The iron corner of the Fe-Zr-C system was studied by thermal analyses and microscopic examination. The numerous phase diagrams of the system which are shown indicate several of the composition ranges to be precipitation hardening. Studies of some Zr steels containing from 0.1 to 0.9% C and from 0.5 to 3.5% Zr indicated that the presence of the Fe-Zr compound lowered the hardness, but that the ZrC compound raised the hardness. The structure of quenched Zr steels consisted of martensite which was less brittle than ordinary Fe-C martensite. SE (10)

The Constitution Diagram of the Manganese Silicon Alloys (Das Zustandsschaubild Mangan-Silizium). R. Vogel & H. Bedarff. *Archiv für das Eisenhüttenwesen*, Vol. 7, Jan. 1934, pages 423-425. Thermal analyses and microstructural studies were made. The reported compound Mn_2Si appears to be the compound Mn_5Si_3 with about 3% more Si. There is also present a compound Mn_3Si with a solubility range of about 1%. Si raises both the 770° and 1100° C transformations of Mn. A rather complete Mn-Si equilibrium diagram is given. SE (10)

The Cobalt-Silicon Equilibrium Diagram (Das Zustandsschaubild Kobalt-Silizium). R. Vogel & K. Rosenthal. *Archiv für das Eisenhüttenwesen*, Vol. 7, June 1934, pages 689-691. A new complete Co-Si diagram is shown with a new compound Co_3Si separating from the melt at 1210° C. and decomposing at 1160° C. The compound Co_2Si has a transformation point at 1332° C., 12° below its melting point. The solid solution β of this compound, saturated at 20.8% Si, decomposes at 1208° C. into solid solution α with 19.8% Si and compound CoSi. The formerly reported compound Co_3Si_2 does not exist. SE (10)

The Metallographic Determination of Size Distribution of Temper Carbon Nodules. H. A. Schwarz. *Metals & Alloys*, Vol. 5, June 1934, pages 139-140. Making certain assumptions regarding the variations in size of carbon nodules, a table of values is constructed by mathematical treatment from which, with experimental values, the size distribution can be determined. WLC (10)

On the Question of the Allotropic Transition of Bismuth at 75° C. Shin'ichi Aoyama & Gohei Monna. *Kinzoku no Kenku*, Vol. 11, April, pages 203-209. In Japanese. *Science Reports Tohoku University*, in English, Vol. 23, pages 52-61. The existence of α and β modifications of bismuth has been sought by many investigators, opinions being divided. Authors studied the problem by means of several physical methods of high sensitivity viz., thermal analysis, thermal expansion, thermoelectromotive force, and oil dilatometer. The curves obtained from these methods are always smooth and show no abrupt change. Hence an allotropic transition of bismuth at 75° C. does not exist. KT (10)

Electron Microscope as a Super-Microscope (Das Elektronenmikroskop als Übermikroskop). Ernst Ruska. *Forschungen & Fortschritte*, Vol. 10, Jan. 1, 1934, page 8. Reports an electron microscope which has been recently constructed in the Technische Hochschule Berlin and which operates with 60-80 kvolt fast electrons. After a 2-stage magnification by magnetic coils, the picture is made visible on the screen and can be photographed. The radiation intensity is raised by a condenser coil which collects the electron radiation emitted from the cold cathode of an ion tube. The work is mounted between 2 Cu apertures of 0.3 mm. diam. Extreme magnifications of 20-30,000 x are now realizable. The magnetic coil furnishes a suitable lens. Heat dissipation and vibrations of the apparatus tend to introduce some inconveniences. Visual examination is not affected by the latter source of trouble. An 8400 x magnification of 0.8μ Al foil is presented. EF (10)

Nature of Disturbances of Crystal Lattice and Their Distribution in Specimen Rods for Tensile and Endurance Bending Tests (Ueber das Wesen der Kristallgitterstörungen und ihre Verteilung in Zug-und Dauerbiegestäben). Fritz Regler. *Mitteilungen des Technischen Versuchsamtes*, Wien, Vol. 22, 1933, pages 49-60. According to present views the majority of elementary cells of a polycrystalline metal undergo the same deformations as the metal itself under elastic deformation so that elastic stresses and elastic modulus can be calculated from the change of the average lattice parameter. These changes are determined by the width of X-ray interference lines; a modification of the usual method is described which yields sharper lines and makes, therefore, more exact measurements of the width of the lines possible. The increase in width of a line is due to energy supplied to the atom and to the potential energy stored in it, and the total energy is composed of the acting forces, the deformations wrought by the forces, and the duration of the action of the forces. As the width of the line at the fracture of a material can be measured, conclusions can be drawn (if proper calibration curves have been established) with regard to life of a metal or structure. In general, the ability for plastic deformation of a metal is the greater the smaller the width of interference lines; other mechanical properties do not show such a simple relation. Tests and results are given in detail. 10 references. Ha (10)

PROPERTIES OF METALS & ALLOYS (11)
Non-Ferrous (11a)

A. J. PHILLIPS, SECTION EDITOR

Tantalum as a Working Material (Das Tantal als Werkstoff). S. GAUSWINDT & K. MATTHEIS. *Die Chemische Fabrik*, Vol. 6, Dec. 27, 1933, pages 521-523. Metallic Ta is obtained from the ore tantalite by treating it with HF and reducing with Na or electrolyzing, then sintering. It can be obtained 99.9% pure. Ta can be cold worked and becomes stronger through working. By heat treatment the tensile strength can be varied from 35 to 120 kg./mm.^{2} and the Brinell hardness from 40 to 220. Ta can be given a good polish. On account of its low vapor pressure it is useful for vacuum furnace parts. It has good corrosion resistance. Up to 300° C. it is not attacked at all by air or gases. At 600° to 700° the surface becomes colored in air or O and the colors cannot be removed chemically. It is attacked by HF at all temperatures, by 50% KOH at 100°, and by concentrated H_2SO_4 at 200°. At high temperatures it is embrittled by H. Ta is used in radio tubes, for spindles in rayon mills, for tubes for heating units used in hot HCl, for pyrometer protection tubes, and as a substitute for Pt for laboratory electrodes and dishes. CEM (11a)

Antifriction Alloys (Les Alliages de Frottement). SOURDILLON. *Usine*, Vol. 43, May 17, 1934, page 31. Good antifriction metals must contain 2 elements of different hardness: one which is plastic and permits the surface of the bushing to assume the proper position with respect to the shaft, and hard points which serve as supports for the shaft. A cast iron possessing good qualities (for automobile cylinders) has the composition: C 3.2%, Si 1.8%, Mn 0.5%, Ni 1.5%, Cr 0.6%; it can be tempered and annealed. A nitrided cast iron of great hardness is composed of C 1.4%, Si 2.5%, Mn 0.6%, Cr 1.6%, Al 4.4%. The hard elements of antifriction metals should have a fine structure as they are then less fragile and imbed themselves better in the plastic constituent; the hardness should however not be too great; that of the principal constituents should be: Cu_3Sn 300, Cu_3Sn_2 250, Sb 80, Sb_2Sn_3 60. Compositions and properties of Cu-Pb and Cu-Sn alloys are reviewed. Alloys of Pb-Sb-Sn-Cu are used for bearings of very high speed motors in the following compositions: 80-14-5.5-3, or 73-15-10-2, or 60-16-20-2. Cu-Pb alloys up to 50% Pb can be made only with an addition of 1% of a mixture consisting of 55% Zr, 38% Si, 5% Fe, 2% Al, as otherwise the 2 elements do not mix. Ha (11a)

Some Effects of the Addition of Tellurium to Lead. W. SINGLETON & BRINLEY JONES. *Journal Society Chemical Industry*, Vol. 52, Mar. 10, 1933, pages 211-213. See *Metals & Alloys*, Vol. 4, Oct. 1933, page MA 335. VVK (11a)

Lead Bronze is Affected by Alloys. HAROLD J. ROAST. *Foundry*, Vol. 61, Oct. 1933, pages 20-21, 45. See "A Practical Foundry Test on the Effect of Phosphorus, Aluminum and Silicon on Leaded Bronze," *Metals & Alloys*, Vol. 5, May 1934, page MA 218. VSP (11a)

Zinc in Bearing Bronzes (Zink in Lagerbronzen). EDMUND RICHARD THEWS. *Chemiker-Zeitung*, Vol. 57, Nov. 22, 1933, pages 923-925. The addition of several % Zn to low Pb bearing bronzes, in place of Cu or half Sn and half Cu, produces satisfactory or even superior properties. When part of the Sn is replaced by twice as much Zn the structure is not essentially changed. If Zn is used to replace Cu the hardness and impact strength, especially at elevated temperatures, are improved. The wear may be slightly greater in Zn bearing bronzes when first used. Zn improves the casting properties, making the metal more fluid and deoxidizing it. Zn has not been used as much in high Pb bearing bronzes, but is equally harmless in these and can be used to replace part of the Sn. Service tests on high Pb, low Sn bronzes have been good, but have not been as good on low Pb, high Sn and medium Sn, medium Pb bronzes. CEM (11a)

Condition Affecting the Freezing Temperature of Silver. WM. F. ROESER & A. I. DAHL. *Metal Industry*, London, Vol. 43, Sept. 1, 1933, pages 197-200. See *Metals & Alloys*, Vol. 5, Feb. 1934, page MA 37. Ha (11a)

Some Properties of Tin Containing Small Amounts of Silver, Iron, Nickel, or Copper. D. HANSON, E. J. SANDFORD & H. STEVENS. *Journal Institute of Metals*, Vol. 55, Advance Copy No. 677, July 1934, 17 pages. The Sn-rich ends of the Ag-Sn, Ni-Sn, and Cu-Sn systems were investigated. For Ag-Sn a eutectic occurs at 3.5% Ag and 221.3° C. The solid solubility of Ag in Sn is 0.02% at room temperature and 0.06% at 210° C. For Ni-Sn the eutectic does not vary appreciably from the melting point of pure Sn. The solid solubility of Ni in Sn is less than 0.005%. For Cu-Sn the eutectic is between 0.70 and 0.75% Cu and at 226.9° C. The solid solubility of Cu and Sn is less than 0.01% at 220° C. The metals mentioned above can be added to Sn without difficulty. A great increase in tensile strength brought about by quenching Ag-Sn alloys is not permanent at room temperatures. Other alloys did not harden on quenching. Additions of more than 0.4% Fe are without effect, although up to this amount an increase of 40% in the tensile strength is found. Ni up to 0.3% increases strength by 2.1 tons/in.^{2}, but further additions have no influence. Cu up to 2% greatly increases tensile strength for all heat treatments investigated. The influence of different amounts of the several metals on grain size after various treatments was determined. Ag refines grain but does not prevent grain growth. The addition of more than 0.05% Fe or 0.06% Ni prevents grain growth. More than 0.35% Cu prevents recrystallization at room temperature, but from 110° C. upward it produces large grains. 6 references. JLG (11a)

Crystal Re-orientation on Heating Drawn Copper Wires. G. S. FARNHAM & HUGH O'NEILL. *Journal Institute of Metals*, Vol. 55, Advance Copy No. 671, June 1934, 10 pages. On heating to 130° C. the hardness of a cold-drawn Ag-free Cu wire increased but Ag-bearing Cu wires did not. X-ray studies showed that preferred orientation was less developed in the Ag-bearing wires. The effect of the temperature treatment is to reduce the amount of [111] preferment to increase the amount of [100] preferment. In Ag bearing wires the change in orientation on heating is quite small. JLG (11a)

Chemical Lead. *Chemical Trade Journal & Chemical Engineer*, Vol. 94, June 1, 1934, page 417. A note on the revised publication of British Standard Specification No. 334—1934, "Chemical Lead," originally issued in 1928 on the sampling, analysis and requirements for Pb with and without alloying agents. (11a)

Bending Properties of Sheet Metal. *Iron Age*, Vol. 133, Apr. 26, 1934, pages 22-23. Data are abstracted from articles in *Bell Laboratories Record*, Apr. 1934, page 230 by G. R. Gohn (See *Metals & Alloys*, Vol. 5, July 1934, page MA 346), and from *Technical Publication* No. 406, *American Institute of Mining & Metallurgical Engineers*, by W. A. Straw, M. D. Helfrick and C. R. Fischrupp (See *Metals & Alloys*, Vol. 1, July 1931, page 136). Deals with methods of testing and gives results of tests. VSP (11a)

Mechanical Properties of the Alloys of Gold and Copper (Sur les proprietes mecaniques des alliages or-cuivre). W. BRONIEWSKI & R. WESOLOWSKI. *Comptes Rendus*, Vol. 198, Feb. 5, 1934, pages 569-571. Broniewski and Wesolowski record diagrammatically the results of mechanical tests made on the materials referred to in the previous note. The test pieces were 5 mm. diameter, save the impact test pieces which were 1 cm. square in section. The tests involved measurements of elastic limits, tensile strengths, percentage elongations, percentage reductions in area, Brinell hardness numbers, and impact numbers (small standard French test pieces) of the alloys (1) as annealed and (2) as quenched. OWE (11a)

New Copper Alloys. *Chemical Trade Journal & Chemical Engineer*, Vol. 94, Feb. 16, 1934, page 114. A new type of Cu and Cu alloys, known as Kunial alloys, has been developed. These alloys unlike ordinary Cu alloys show an increased hardness and tensile strength when heated to 400°-600° C. They may be extruded, rolled, drawn or cold-worked and show high corrosion resistance. 1 JN (11a)

Effect of Impurities on the Technical Properties of Zinc (Einfluss der Verunreinigungen auf die technischen Eigenschaften des Zinks). WILHELM HERMANN. *Chemiker-Zeitung*, Vol. 57, Dec. 6, 1933, pages 958-959. The amounts of impurities which are harmful depend entirely on the use of the Zn. Cd increases the hardness and brittleness of Zn and makes it difficult to roll and draw. For rolling .20% should be the maximum. Pb is not a harmful impurity in Zn. Rolled Zn may contain up to 1.25%. Pb up to .5% offsets the embrittling action of Cd, Fe, As, and Sb. In rolled brass the Pb should not be over .20%. Fe makes Zn hard and brittle. As little as .015% influences the rolling properties. For galvanizing Fe must not be over .10%. In Zn used for alloying the presence of Fe is not harmful. Fe lowers the corrosion resistance of Zn. Sn does not occur in virgin Zn. It makes Zn very hard and brittle. Rolling is made impossible by .02% Sn. Sn improves the galvanizing properties of Zn, making the articles brighter. As much as .60% is not harmful in galvanizing. It is also not harmful in Zn used for brass alloying. Cu is always low in virgin Zn. Up to .05% is harmless for rolling. It has no effect on the galvanizing properties. As and Sb are harmful for practically all purposes when present in more than traces. Al is intentionally added to galvanizing Zn to whiten and brighten it. 2 CEM (11a)

Precipitation-Hardening Nickel-Copper Alloys Containing Aluminium. D. G. JONES, L. B. PFEIL & W. T. GRIFFITHS. *Engineering*, Vol. 136, Nov. 3, 1933, pages 505-507. From paper read before the Institute of Metals, Sept. 19, 1933. See *Metals & Alloys*, Vol. 5, June 1934, page MA 284. 3 LFM (11a)

Alloy Cast Iron and High Duty Cast Iron in 1933. J. E. HURST. *Foundry Trade Journal*, Vol. 50, Jan. 18, 1934, pages 39-40. Hurst deals first with the developments which have resulted from the introduction of nickel into cast iron, illustrating his points by a diagram showing strengths obtainable with various preparations of nickel and silicon. Cast irons for heavy duty receive some consideration, and the use of molybdenum is dealt with in some detail. The article closes with a discussion of austenitic cast irons. OWE (11a)

Tough, Strong, Permanent Die Castings. D. L. COLWELL. *Metal Progress*, Vol. 23, Dec. 1933, pages 19-23. Improvements in Zn die castings are traced and it is shown that increased purity of Zn base has greatly improved casting quality. Use of 99.99% Zn in compositions at present specified by A. S. T. M. and S. A. E. is required. Alloy XXI, Cu-Al-Mg, shows as cast properties of 44,000 lbs./in.^{2} tensile strength, 2.0% elongation in 2 in., 6 ft. lbs. Charpy impact. After 10 days in water vapor at 200° F. 30,000 lbs./in.^{2} tensile, 0.5% elongation, 0.75 ft.-lbs., Charpy, maximum dimensional change of 0.0024 in./in. Alloy XXIII, Al-Mg-low Cu, shows as cast properties 35,000 lbs./in.^{2} tensile, 3.0% elongation in 2 in., 12.0 ft.-lbs. Charpy. After 10 days in water vapor at 200° F. 30,000 lbs./in.^{2} tenside, 1.5% elongation, 12.0 ft.-lbs. Charpy, maximum dimensional change of 0.001 in./in. Aging in steam bath is more severe than actual service on impact strength. Reduction of Cu to very low value and lower Mg in alloy XXIII has eliminated greatly deterioration with aging and produced stable properties. 4 WLC (11a)

The Kunial Copper Alloys. *Engineering*, Vol. 137, Feb. 16, 1934, pages 175-176. Briefly cites changes in physical properties of these new alloys brought about by proper heat treatment. The alloys have been developed by the research department of Messrs. I. C. I. Metals, Limited, Birmingham. The exact composition is not given but another alloy with similar properties contains Cu 72.5, Ni 6.0, Al 1.5 and Zn 20%. 5 LFM (11a)

Tungum Alloy. *Engineering*, Vol. 137, April 27, 1934, page 485. Short note giving properties of a new alloy being marketed by Tungum Sales Co., Ltd., London. It was named for the metallurgist, Tungay, who discovered it. No exact analysis is given but it is said to be a Cu-rich alloy containing additions of Zn, Si, Al and Ni alloyed by a special process. 6 LFM (11a)

Ferrous (11b)

E. S. DAVENPORT, SECTION EDITOR

Electric Manganese Steel Rail of the Austrian Alpine Steel Corporation Donawitz Works, Steiermark (Die Elektro-Manganstahl-Schiene der Oesterreichisch-Alpine Montangesellschaft, Werk Donawitz, Steiermark). M. ROS. *Eidgenössische Material-prüfungsanstalt der Eidgenössischen Technischen Hochschule Zürich.* Report 77, Oct. 1933, 24 pages. Discusses results of laboratory and service tests on electric Mn steel rails. Composition: C = .50 -.65%, Mn = 1.7-1.9%, Si $\geqq$ .35%, P .02% max. and S .02% max. Mechanical properties: Brinell hardness 250-275; tensile strength 88-96 kg./mm.^{2}; yield point 48-52 kg./mm.^{2}; elongation 10-13%; deformation of flange transversely $\geqq$ 8 mm.; deflection on rupture in shock tests—rail flange in tension—f $\geqq$ 80 mm.; rail head in tension—f $\geqq$ 60 mm.; very high resistance to wear. Owing to the high Mn content the microstructure is eutectoid, mostly sorbitic, with fine lamellar pearlite and isolated ferrite patches. This sorbitic structure which is developed without special heat treatment possesses high resistance to wear. The particular chemical composition coupled with cleanliness, appropriate manufacture and handling in steel plant and rolling mill result in the excellent properties. Such rails in use since 1928 in the experimental tracks of the Austrian Semmering and Arlberg Railway, and since 1931 in those of the Swiss Gotthard Railway on a grade with sharp curves and in an unfavorable climate with heavy daily traffic have proved their exceptional service qualities. They are 3 times more resistant to wear than basic Bessemer and open hearth rails of 75 kg./mm.^{2} tensile strength. The electric Mn tramway grooved rails laid in the very sharp curves of the Vienna Municipal Tramways, where the traffic is very heavy, have double the life of open hearth tramway grooved rails. 7 8 GN (11b)

Columbium to Stabilize 18-8 Steel. JOHN A. MATHEWS. *Metal Progress*, Vol. 26, July 1934, pages 19-21. Columbium (Nb. niobium) addition to 18-8 for stabilization against susceptibility to intergranular corrosion and loss of impact strength is more satisfactory than Ti because of practically complete oxidation of Ti in welding. 9 WLC (11b)

Alloys and Malleable Iron. HERBERT R. SIMONDS. *Iron Age*, Vol. 133, Apr. 5, 1934, pages 27-28. Discusses significance of recent developments in alloy Fe and steel and stresses the need of a new terminology. Quotes several authorities on the subject. VSP (11b)

Production and Properties of Superior Cast Iron—With Special Reference to Meehanite. OLIVER SMALLEY. *Foundry Trade Journal*, Vol. 49, Nov. 23, 1933, pages 289-291. Characteristics of Meehanite are discussed at some length. 10 OWE (11b)

Thermal and Electrical Conductivities of Metals and Alloys. J. W. DONALDSON. *Metallurgia*, Vol. 10, May 1934, pages 17-19. Discusses Wiedemann-Franz ratio and shows that it does not predict the relationships between electric and thermal conductivity in alloys as well as in the case of pure metals. With cast iron, in particular, it fails to predict the true relationship. See also *Metals & Alloys*, Vol. 5, May 1934, page MA 225. JLG (11b)

The Elasticity, Deflection and Resilience of Cast Iron. J. G. PEARCE. *Iron & Steel Institute, Advance Copy* No. 16, May 1934, 18 pages; *Engineering*, Vol. 137, June 1, 1934, pages 635-637. In the transverse test of cast iron part of the deflection results from elastic deformation and part from plastic deformation. In order to separate these two types of deformation samples were loaded by increments, the load being removed after each increment, and the deflections under load and after removal of load determined. The elastic deflection is proportional to the load, while the plastic deformation increases more rapidly than the load. The elastic modulus calculated from the elastic deflection was in the neighborhood of 20×10^6 lbs./in.^{2} for gray irons. Significance of different test values on cast iron is discussed and it is concluded that resilience, the product of breaking load and deflection, obtained from transverse tests, distinguishes tough from brittle iron. 5 references. LFM+JLG (11b)

Most Recent Developments of Cast Iron (Streiflichter auf die neueste Entwickelung des Gusseisens). G. MEYERSBERG. *Die Giesserei*, Vol. 21, April 27, 1934, pages 169-173. Most recent developments in practical application of scientific data to manufacture of improved cast Fe are reviewed and results of machinability, wear and structure tests discussed. Methods of control of C in the cupola furnace are described. Cast Fe is considered not only in the light of its strength, but from the viewpoint of a factor which expresses the kind of deformation under load; this factor is obtained from the deformation curve up to fracture and can be expressed with sufficient accuracy by $Z_f = 100 \times F/\sigma'_B$ where f denotes the deflection at fracture in mm. and σ'_B the bending strength in kg./mm.^{2} Machinability is defined by the relative velocity in m./sec. between piece to be machined and an exactly defined tool when the latter has become dull after one hr. Method of ascertaining this "hourly cutting velocity" is described. Heat treatments to give the cast Fe permanency of structure are briefly reviewed. 19 references. Ha (11b)

Contributions to the Thermochemistry of Iron (Beiträge zur Thermochemie des Eisens). W. A. ROTH & F. WIENERT. *Archiv für das Eisenhüttenwesen*, Vol. 7, Feb. 1934, pages 455-460. Using synthetic finely divided materials, the heats of formation of iron oxides at room temperature were determined in a solution colorimeter with hydrochloric acid. The following values were obtained at 20.7° C.

$$[Fe] + \tfrac{1}{2}(O_2) = [FeO] + 64.6_5 \pm 0.1_2 \text{ Kcal}$$
$$3[Fe] + 2(O_2) = [Fe_3O_4] + 266.7_6 \pm 0.2_2 \text{ Kcal}$$
$$2[Fe] + 1\tfrac{1}{2}(O_2) = [Fe_2O_3] + 195.1_9 \pm 0.2_0 \text{ Kcal}$$
$$[FeO] + [Fe_2O_3] = [Fe_3O_4] + 6.9_4 \pm 0.3_2 \text{ Kcal}$$
$$[Fe] + 1\tfrac{1}{2}(Cl_2) = [FeCl_3] + 93.5_6 \pm 0.2_3 \text{ Kcal}$$
$$[Fe_2O_3] + 3(Cl_2) = 2[FeCl_3] + 1\tfrac{1}{2}(O)_2 - 8.0_7 \pm 0.4_4 \text{ Kcal}$$

SE (11b)

Castability of Cast Irons (La Coulabilité des Fontes). S. PERIN. *La Fonderie Belge*, Vol. 3, Nov.-Dec. 1933, pages 160-175. General report on research supported by the National Belgian Fund for Scientific Research. Investigations have dealt chiefly with influence of common elements on castability of cast Fe. Summarized conclusions of the work are: (1) effect of C; at constant temperature, castability increases with C content up to 4.3% and then decreases; for a constant super-heat (constant difference between casting temperature and liquidus temperature) increase in castability is small up to 4% C and then large between 4 and 4.3%; (2) effect of P; at constant temperature, P increases castability in hypo-eutectic range and decreases it in hyper-eutectic range; (3) effect of Si; minima of castability have been noted for contents of 0.50 and 0.95%; at higher Si contents castability increases with increasing Si; between the 2 minima a maximum of castability appears at 0.75% Si. FR (11b)

Progress in the Field of Permanent Magnets (Fortschritte auf dem Gebiete der Dauermagnete). KOTARO HONDA. *Metallwirtschaft*, Vol. 13, June 15, 1934, pages 425-427. The Magnet steels formerly used, W steel, K.-S. magnet, M.-K. magnet, Köster's, and Katos' magnet steels are discussed and their deficiencies described. In 1933 the author developed a new K.-S. magnet steel, containing 15-36% Co, 10-25% Ni, and 8-25% Ti, which has better magnetic properties. For best results it is quenched and drawn at 660° C. Like the better of the former magnet steels it consists of a large number of small crystals. Its retentivity and coercive force depend on the composition and the intensity of the magnetizing field. Examples are 6356 to 7600 c. g. s. units for retentivity and 920 to 788 for coercive force. These magnets are affected only slightly by heat and shock, but they are difficult to forge. Rockwell hardness of the heat treated steel is C 50 and sp. gr. 7.3. Hysteresis curves, relations between retentivity and size and between retentivity and drawing temperature are given. This steel is especially suitable for magnets of short length. CEM (11b)

New Approaches to the Deformation of Steel. E. J. JANITZKY. *Iron Age*, Vol. 132, Nov. 2, 1933, pages 14-17, 70. Analysis of deformation of steel tensile test specimen, the interrelation of elongation and reduction in area in the tensile test and apparent relation of deformation to other physical properties such as stress, notch toughness and machinability. Relationship between elongation and reduction in area is termed "deformation constant," constant having different values depending on size of quenched section and speed of cooling. Deformation constant appears to be an index of machinability. VSP (11b)

Molybdenum as an Aid in the Iron Foundry. CARL M. LOEB, JR. *Iron & Steel of Canada*, Vol. 17, Jan.-Feb. 1934, pages 9-11. Article with 6 diagrams, dealing with uses to which Mo has been put in Fe foundry practice. OWE (11b)

High Test, Heat Treated Alloy Cast Iron. E. F. LAKE. *Heat Treating & Forging*, Vol. 20, May 1934, pages 233-236. Discusses effect of adding Cr, Ni, V, and Mo, usually in combination. Most of these elements retard graphitization, cause the graphite to precipitate uniformly and in finely divided condition, refine the grain, and improve physical properties. Use of automatic rocking electric furnaces has made possible accurate production of high-test cast-Fe. MS (11b)

Specification for Chrome Tungsten Steel Castings. BLAINE B. WESTCOTT. V. T. MALCOLM & HERBERT HENDERSON. *Refiner & Natural Gasoline Manufacturer*, Vol. 12, July 1933, pages 281-292. Specification covers steel castings containing approximately 5% Cr and 1% W intended for use in petroleum refining operations under corrosive conditions at elevated temperatures and high pressures. This development resulted from a cooperative investigation by Gulf Research and Development Corp., and Chapman Valve Manufacturing Co. Detailed data on physical properties, heat treatment, X-ray examination and structure are given. VVK (11b)

Properties of Nickel-Alloy Cast Irons and Their Special Applications in Petroleum-Production Equipment. O. B. J. FRASER & J. S. VANICK. *Preprint Mid-Year Meeting, American Petroleum Institute, Production Division*, May, 1934, 15 pages. Effect of alloying elements, particularly Ni and Cr on the physical properties, heat treatment, microstructure and corrosion resistance of cast iron. Specifications for many applications are also given. 11 references. VVK (11b)

Chromium-alloy Steels in Heat Treatment. J. W. URQUHART. *Mechanical World & Engineering Record*, Vol. 94, Nov. 17, 1933, pages 1106-1107. Review of various grades of Cr-steels. As cost varies greatly among these grades, it is necessary to understand differences in properties and methods of treatment for application to be economical. Kz (11b)

Chrome-Molybdenum Cast Iron at Mine Plant Foundries. R. H. CROMWELL. *Engineering & Mining Journal*, Vol. 135, June 1934, page 256. The addition of Mo to the charge of a small cupola iron furnace, at Minas de Matahambre, Cuba, from which are poured various castings to be used at the mine, concentrator, power plant, and docks has resulted in the production of castings at economical prices with longer life than ordinary cast iron products. WHB (11b)

EFFECT OF TEMPERATURE ON METALS & ALLOYS (12)

L. JORDAN, SECTION EDITOR

The abstracts in this section are prepared in co-operation with the Joint High Temperature Committee of the A.S.M.E. and the A.S.T.M.

Bearing Metals at Elevated Temperature. *Commonwealth Engineer*, Vol. 21, Jan. 1, 1934, pages 157-158. At service temperatures of 200° C., Sn-base bearing alloys have a much reduced hardness. According to Kenyon, Pb is not injurious in Sn base alloys at elevated temperatures but increases the hardness at air temperature. (With reference to additions of 1-14% Pb to a 91 Sn, 4.5 Sb, 4.5 Cu alloy). Creep tests of Swartz & Phillips indicate marked superiority of Cd alloys, whose creep limit was 10 times that of a babbitt alloy. The former were suitable for light and heavy loads, both low and high speeds and variable loads. Further tests yielded:

Alloys	Compression at 200° C. and 20% reduction:	Brinell hardness at 200° C.
88.6 Sn, 5.2 Cu, 6.2 Sb	3,500 lbs./in.^{2}	3.7
97 Cd, 3 Ni	5,000 " "	8.3
98.75 Cd, 1.3 Ni	7,000 " "	6.5

WH (12)

Thermal Effects in Elastic and Plastic Deformation. M. F. SAYRE. *Metal Industry*, London, Vol. 41, Aug. 12, 1932, pages 153-156. See *Metals & Alloys*, Vol. 4, Aug. 1933, page MA 268. Ha (12)

Influence of Temperature upon the Elastic Properties of Aluminum Casting Alloys (Einfluss der Temperature auf die elastischen Eigenschaften von Aluminumgusslegierungen). M. v. SCHWARZ & A. EVERS. *Zeitschrift für Metallkunde*, Vol. 26, Feb. 1934, pages 37-39. Measurements of Young's modulus and yield point (0.001% elongation) were made upon a German Al-Zn casting alloy and an American casting duralumin (both age-hardened) at temperatures of 20°, 100°, 150°, 200°, and 250°. For the German alloy Young's modulus decreased from 8200 kg./mm^2 at 20° to 2900 kg./^{2} at 250°, while the yield point fell from 9 kg./mm^2 at 20° to 1 kg./mm^2 at 250°. For the American alloy similar values are as follows: Young's modulus, 7700 kg./mm^2 at 20° and 4000 kg./mm^2 at 250°; yield point, 7.7 kg./mm^2 at 20° and 3.7 kg./m..^{2} at 250°. Accordingly the American alloy is more suited for high temperature service. RFM (12)

Strength of Copper at Elevated Temperatures with Static and Dynamic Loading (Untersuchungen über die Warmfestigkeit von Kupter bei statischer und bei Wechselnder Beanspruchung.) W. SCHWINNING & E. STROBEL. *Zeitschrift für Metallkunde*, Vol. 26, Jan. 1934, pages 1-5. Data are given. On Young's modulus, yield point (0.01, 0.05, 0.2% elongation), tensile strength, elongation, bending numbers, and various ratios of these quantities—for hard drawn conductivity Cu at 20°, 100°, 200°, and 300°. The microstructure showed evidences of recrystallization on reversed bending at 200°. These data on Cu are compared to similar data on hard drawn and annealed Al and the alloy Lautal. RFM (12)

Impact Resistance of Cast Iron at Elevated Temperatures. F. B. DAHLE. *Metals & Alloys*, Vol. 5, Jan. 1934, pages 17-18. A study of the impact resistance, tensile impact and unnotched Charpy, of 2 cast irons of the following compositions:

	T.C.	C.C.	Si	Mn	P	S	Mo
No. 99	2.63	0.96	1.75	0.63	0.051	0.090	0.82
No. 108	2.81	0.70	1.69	0.86	0.073	0.028	...

The tensile impact test results in greater selectivity. At room temperature and up to 800° F. the Mo iron shows superiority which drops off at higher temperatures. The shock resistance of cast irons is not markedly improved at any temperature up to 1000° F. in which range it must be considered a relatively brittle material. WLC (12)

Strength of Steels at low temperatures (Zugfestigkeit von Stahlen bei tiefen Temperature). G. GRUSCHKA. *Forschungsheft 364 supplement to Forschung auf dem Gebiete des Ingenieurwesens* Series B, No. 5, Jan.-Feb. 1934, 20 pages. A study of the properties of steels under static tensile tests at temperatures down to —195°C. (—320°F.). A special extensometer and the thermostat and bath for cooling, are described. Several carbon steels with 0.08 to 0.23% C, 0.35 to 0.71% Mn, 0.19 to 0.25% Si, 0.01 to 0.02% P and 0.01 to 0.03% S, as well as Armco iron, one steel containing 0.40% C, 0.80% Mn, 0.25% Si, 0.04% each S and P, and 4 nickel steels, were tested, all apparently in the as-rolled condition. The carbon steels (excluding Armco iron) acted much alike, showing a gradual increase in tensile strength of some 20% from room temperature down to about —100°C. (—150°F.), but a much more rapid rise from there to —195°C. (—320°F.), coming up to a 60 or 70% increase. The upper yield strength curves appear rather erratic, but the lower yield strength curves parallel the tensile strength curves fairly well, but generally approach them more closely at the lowest temperatures. The effect of increase in carbon content was to increase the strength at low temperatures in about the same ratio as at room temperature. At about —160°C. (—255°F.), the ductility, especially the reduction of area, fell off sharply in the carbon steels, till at —195° C. (—320° F.), the reduction was only from 1/2% to 11%. No clear effect of carbon is discernible, the 0.40% C steel dropping off at about the same temperature as the others. The 0.08 and 0.11% C steels had more ductility left at —195° (—320°F.) than the higher carbon steels, but the 0.15% C steel was no better than those of still higher carbon. Armco iron showed a greater percentage increase in strength at the very low temperatures than did the steels, the drop in ductility came at a higher temperature, and at —195°C. (—320°F.) it was the least ductile of any of the materials tested. The nickel steels of 3 to 3.8% Ni, 0.11 to 0.23% C and 0.2 to 0.7% Cr showed a more gradual increase in strength as the temperature was lowered nor did the yield strength tend to approach the tensile strength, while the sharp drop in ductility occurred below —183°C. (—300°F.) instead of —160°C. (—255°F.). At —195°C. (—320°F.), however, they were no more ductile than the 0.08 and 0.11% C steels. A 0.13% C, 5.13% Ni, 0.2% Cr steel remained tough at —195°C. (—320°F.). Its strength and reduction of area at that temperature were 169,000 lbs./in.^{2}, 50%, respectively, as compared with 103,000 and 74% at room temperature. It is therefore considered the most suitable steel for use in the liquid oxygen and liquid nitrogen industry. No impact determinations were made in this investigation. (Abstractor's note: Dynamic toughness in the carbon steels would be lost at higher temperatures than is shown by Gruschka's static data.) HWG (12)

Relation between Ordinary Strength and Creep Strength. ATSUMARO SHIMIZU. *Journal of the Society of Mechanical Engineers*, Vol. 36, Dec. 1933, pages 831-834. (In Japanese) Paper read before the Meeting of the Society of Mechanical Engineers at Sendai, Dec. 10, 1932. The author states that the curve of the creep limit and that of the original or primary strength are nearly parallel to each other, and that the ratio of the creep strength to the ordinary strength is constant, independent of the material. Kz (12)

Creep Strength of 18-8 After Four Years' Service. F. H. NORTON. *Metal Progress*, Vol. 25, June 1934, pages 50-51. Creep tests upon material of a 4-in. diameter 1/4-in. wall tube removed after 31,100 hr. service in an oil cracking still at 925°-975° F. are reported showing the service to be without effect upon load carrying capacity. Some carbide precipitation was evident but no intergranular corrosion. WLC (12)

IT HAS been estimated that in the life of the average motor car each spring is flexed approximately 30,000,000 times. In view of that, the need in spring steel for fatigue-resistance above all else requires no emphasis.

High fatigue-resistance depends more on the care exercised in making the steel than on the analysis. From the time silico-manganese spring steel was pioneered in Bethlehem's plants a quarter of a century ago, Bethlehem metallurgists have been in close, every-day touch with the problems of spring-makers. No stone has been left unturned in the effort to make steel that facilitates the manufacture of fine springs of long life.

When Bethlehem makes spring steel the surface is carefully processed at all stages to avoid the slightest imperfection that might provide a starting-place for fatigue. The grain-structure is controlled with extreme accuracy to insure steel of both high inherent fatigue-resistance and uniform heat-treating characteristics. The result is a smooth, continuous flow of springs through the heat-treatment processes in the factory.

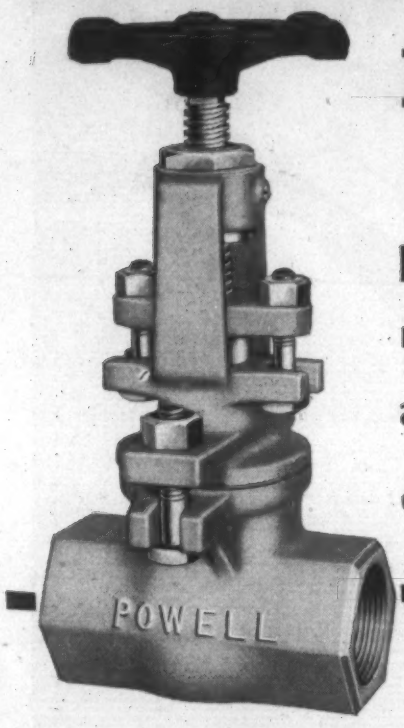
Springs possessing the utmost fatigue-resistance the analysis is capable of developing are assured when the steel is made by Bethlehem.

BETHLEHEM STEEL

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

BETHLEHEM *fine* ALLOY STEELS

On Guard



ILLIUM-G VALVES

present impregnable defense to acids and other corrosive liquids

SHUT-OFF valves made of ILLIUM-G render leak-proof duty for indefinite periods. Once installed, there is no uncertainty about an ILLIUM-G valve doing its duty. Because ILLIUM-G takes a smooth, even finish, its seating qualities are above average. But even more important to satisfactory valve performance is the following outstanding characteristic of this superior corrosion-resisting alloy:

Corrosion resistance is *inherent in* ILLIUM-G

Many alloys are resistant to corrosion only when a protective coating, formed during the process of corrosion, is not disturbed during use of the part. But—ILLIUM-G provides a continued high resistance to corrosion even when its surface is constantly re-exposed by friction from packing glands or by some other part coming into close contact with the ILLIUM-G surface.

Tests in actual service involving wear on the surface of alloys show immediately the superior corrosion resistance of ILLIUM-G under all conditions. This test is the determining factor in continued satisfactory service.

Illium-G ON THE JOB

If you have equipment subjected in whole or in part to corrosive conditions, we are glad to offer our facilities in helping you to a satisfactory solution. Just send us a sample or sketch of the part, describe the conditions involved and we'll give you our recommendations. BURGESS-PARR COMPANY, Division of C. F. Burgess Laboratories, Inc., Moline, Illinois.

ILLIUM-G

REG. U. S. PAT. OFF.

The CORROSION RESISTING ALLOY

CORROSION & WEAR (13)

V. V. KENDALL, SECTION EDITOR

1 **Stresses in Rails, Their Sources and Effect on the Safety Against Fracture (Spannungen in Schienen, ihre Ursachen und ihre Wirkung auf die Bruchsicherheit).** KÜHNEL. *Organ für die Fortschritte des Eisenbahnwesens*, Vol. 88, July 1, 1933, pages 257-260. Critical comment on a previous paper of Spindel (See *Metals & Alloys*, Vol. 5, Apr. 1934, page MA 162. Typical fractures are illustrated showing the many causes leading to fracture and failure of rails. Kühnel holds that hard rails are not unsuitable for railroads, in spite of the fact that failures due to transverse fissures begin at a Ten.Str. of about 100 kg./mm². The cross section of a rail should be submitted to hardness tests rather than to tensile tests since the latter are liable to lead to wrong results in case of hard materials like these. The Ten.Str. can be calculated from the hardness test. Around 90 kg./mm.² Ten.Str., a favorable gain in resistance towards wear and deformation is attained. Cold work due to the effect of the relatively small area of contact in a rail results in a hardness gain which seems to approach a mean Ten.Str. value of about 95 kg./mm.² with respect to rail steels now in service. Harder rails than employed nowadays consequently eliminate the danger of notable deformation. Kühnel denies that the stresses due to cold working in service endanger the life of the rail in regard to fatigue failure and criticizes previous work in that the appearance of rail fractures has not been studied adequately and presented as indispensable evidence of conclusions. The writer furthermore stresses a recent result on vibration endurance tests, established in various research institutions, which show that stressing within the elastic limit without cold deformation cannot be accounted for as a detrimental additional load. The endurance strength of samples submitted to pre-stresses does not drop but increases. Tests on the German structural steel St. 52 yielded a normal fatigue strength of 27 kg./mm.² which was raised to 29 and 34 kg./mm.² due to pre-stressing by 5 and 20 kg./mm.² respectively. EF (13)

2 **The Usefulness of Corrosion Tests to the Chemical Engineer.** A. S. WHITE. *Industrial Chemist*, Vol. 10, Mar. 1934, pages 98-101. 23 references. A classification and brief discussion of various corrosion tests which have been previously reported. RAW (13)

3 **Preventing Corrosion After Machining.** V. W. WELLS. *Machinery*, New York, Vol. 39, Mar. 1933, pages 475-476. Cutting oil will form a light film which protects the surface against corrosion for a time. Mineral oil which has been acid treated or animal oils that will develop free fatty acids on exposure to the atmosphere will permit corrosion. Sulphonated cutting oils are recommended for preventing corrosion. Emulsified cutting oils are unsatisfactory for resisting corrosion. RHP (13)

4 **Heavy Steel Trusses over Acid Plant.** NEWMAN TATE. *Mechanical World & Engineering Record*, Vol. 95, Apr. 13, 1934, page 351. To minimize corrosive action and facilitate protective painting. steelwork which is exposed to the action of highly corrosive gases should be designed to have as little surface area as possible. Discussion of example. Kz (13)

5 **Mechanism of Dezincification Corrosion of ϵ-Brass.** CHARLES W. STILLWELL & EDWARD S. TURNIPSEED. *Industrial & Engineering Chemistry*, Vol. 26, July 1934, pages 740-743. Paper presented before the Division of Physical and Inorganic Chemistry at the Chicago meeting of the American Chemical Society, Sept. 1933. From X-ray diffraction data it has been found that the corrosion of ϵ-brass may occur in at least three different ways: (1) In strong oxidizing agents (nitric acid) both Cu and Zn are dissolved; a trace of Cu is redeposited from very dilute nitric acid. (2) In acid of intermediate strength (normal sulphuric, concentrated HCl) both Cu and Zn are dissolved and Cu is redeposited. (3) In very weak acids (dilute HCl, acetic) only Zn is removed from the alloy, resulting in the successive formation of γ-brass, β-brass, and Cu or α-brass. Dezincification may occur in two ways: (1) by the solution of Cn and Zn and the redeposition of Cu in strong corroding agents; (2) by the solution of Zn only in weak corroding agents. MEH (13)

6 **New Boiler-Water Treatment for the United States Navy.** THORVALD A. SOLBERG & ROBERT C. ADAMS. *Marine Engineering & Shipping Age*, Vol. 39, Mar. 1934, pages 109-110. See *Metals & Alloys*, Vol. 5, June 1934, page MA 294. Kz (13)

7 **Concerning the Topochemistry of Metallic Magnesium. A Contribution to the Knowledge of Metallic Corrosion.** R. A. VYSKOCIL. *Collection of Czechoslovak Chemical Communications*, Vol. 6, Jan.-Feb. 1934, pages 1-16. In English. In solutions of ammonium salts (similarly as in solutions of salts of alkali and alkaline-earth metals) Mg decomposes water, the Mg hydroxide formed dissolving in presence of ammonium ions. In solutions of ammonium salts acidified beforehand the velocity of dissolution of metallic Mg decreases first, until the solution is neutralized, increasing then for a certain time. A slight alkalinity promotes the reaction in solutions of ammonium salts, a stronger alkalinity, however, has generally an impeding influence with all salts, the surface of Mg becoming considerably resistant and retaining its metallic luster in more concentrated solutions of alkali hydroxides. The catalytic effect of salts on the decomposition of water by Mg is generally due chiefly to anions; some oxidizing anions, however, especially the dichromate ion, passivate the metal. The decomposition of water is preceded by adsorption of the anions of the salt on the discontinuities of the metallic surface, the free atoms of magnesium in the vicinity of the complexes formed becoming activated for the reaction. The corrosion formed on magnesium in salt solutions is very typical for many anions. The velocity of formation of corrosion on the surface of Mg in aqueous solutions of salts of metals depends, other conditions being equal: (1) on the degree of adsorbability of the ions present, (2) on the nature of the catalyzing anions, the chloride ions being the most active of the ions investigated, and (3) on the nature of the metallic surface, which may be inhomogeneous either in its original state, or made so by a subsequent chemical action. A more active anion can be disturbed in its action by the presence of less active anions with a greater adsorbability, the surface of Mg being "poisoned" (passivated) in this instance more or less for the action of the more active anion. In salt solutions the decomposition of water takes place on the originally (or owing to a later action) inhomogeneous surface of metallic Mg most probably in the sense of a conception put forward by Kistiakowski for the Mg electrode:

8 $Mg + 2OH^1 = Mg(OH)_2$ (precipitated) $+ 2\Theta_1$

9 $H_2O + 2\Theta = H_2 + 2OH^1$

Summarily:

$Mg + H_2O = Mg(OH)_2$ (precipitated) $+ H_2$

The more differentiated is the Mg surface for the possibility of exchange of charges in the sense of these equations, the higher is the velocity with which corrosion becomes deeper and darker in presence of different salts. In this action sometimes a black substance, the so-called Mg suboxide (probably a mixture of disintegrated Mg with Mg hydroxide) is formed, this happening also when a wire of another metal is wound around the Mg sheet. The "suboxide" is formed sporadically even without presence of a conducting admixture in solution of chlorides, especially when these are dissolved in not too concentrated solutions of alkali hydroxides. Also the transient black coatings on the surface of Mg in solutions of bicarbonates are probably the mentioned "suboxide," which is here formed after a previous spontaneous etching of the metal with carbonic acid on certain spots (the anodes) of the surface. An explanation of the observed phenomena is attempted, which is based on primary adsorption promoting the catalytic process of corrosion. 14 references. GTM (13)

10

CHASE

OLYMPIC BRONZE

Springs of Chase Olympic Bronze are highly resistant to fatigue and corrosion.

For literature write to:

CHASE BRASS & COPPER CO.
—Incorporated—
Subsidiary of Kennecott Copper Corporation
WATERBURY, CONN.

RYERSON STEEL

IN STOCK—IMMEDIATE SHIPMENT

Years of experience—rigid specifications—careful checking and testing—large and complete stocks—unequalled cutting and shipping facilities—is your assurance of quality steel—delivered the very hour you need it. All the newer steels, special alloys, stainless and cold finished steels, also non-ferrous metals and allied lines are included.

Ryerson experienced steel men will help you solve any steel problem. Ask them for suggestions.

Write for Stock List

Joseph T. Ryerson & Son, Inc.: Chicago, Milwaukee, St. Louis, Cincinnati, Detroit, Cleveland, Buffalo, Boston, Philadelphia, Jersey City.

Working in Stainless? Consider ARMCO

WHATEVER you manufacture of stainless steel sheets, strip and plates, we believe you can make it a little better, a little easier, a little more attractive and serviceable with ARMCO STAINLESS STEELS. Why? Because we go to great lengths to insure that their analysis, their composition, is just right for your purpose. Using the right equipment and the right methods, ARMCO STAINLESS STEELS will respond to any demands of fabrication economically and satisfactorily. Each surface finish is excellent for its class. Corrosion resistance, heat resistance, and immunity from many different forms of chemical attack is all that you would ask. In short, ARMCO STAINLESS STEELS give you every good quality, good feature and advantage that you want. And they cost no more. Shall we survey your needs and help you apply with profit the right grade for the right use?

THE AMERICAN ROLLING MILL COMPANY

Executive Offices: Middletown, Ohio

ARMCO *Stainless Steels*

Reaction of Some Light Alloys to Marine Corrosion (Sur la tenue de quelques alliages legers a la corrosion marine). J. COURNOT, M. CHAUSSAIN, & H. FOURNIER. *Comptes Rendus*, Vol. 198, Jan. 3, 1934, pages 85-87. Two series of aluminum alloys, (1) containing 6-9% Mg and a little Mn and Si, (2) containing 2-3% Mg, 1-3% Mn, 0.2-0.5% Sb, and a little Si, have been investigated by immersion and alternate immersion at room temperature for 25 days. Tests on rolled alloys—(a) 9.05% Mg, 0.37% Mn, and 0.21% Si; (b) ordinary duralumin; (c) special duralumin containing nickel and chromium in unstated proportions—showed mean losses of weight of 15.00, 23.15 and 16.40 g./m.², respectively. The appearance of the corroded samples differed considerably, (b) and (c) being uniformly attacked while the central areas of the (a) samples were selectively affected. Stampings were also treated—(d) 8.65% Mg, 0.54% Mn, 0.32% Si (a series 1 alloy); (e) 2% Mg, 1.5% Mn, 0.55% Si, 0.2% Sb, and (f) 2.4% Mg, 3.05% Mn, 0.3% Si, 0.4% Sb (two series 2 alloys). The mean losses of weight were 43.10, 29.25, and 28.25 g./m.², respectively. The appearance of the stamped specimens was similar to that of the rolled specimens. While series 2 alloys are distinctly superior in their resistance to corrosion to series 1 alloys, their mechanical properties are inferior. Tests made on two alloys—(g) 8.85% Mg, 0.64% Si, 0.03% Mn, and (h) 9.18% Mg, 0.66% Si, 0.34% Mn, neither containing copper—indicated that, due to its higher Mn content, the latter showed less than half the loss of weight of the former, which confirms work of Herzog and Chaudron (Comptes Rendus, Vol. 196, 1933, page 2002). It is concluded that in the first series of alloys there are some of importance for marine purposes, though their resistance to corrosion varies considerably with slight alterations in composition, and considerable care and the finest materials must be used in their manufacture. OWE (13)

Metal Coatings as Corrosion Protection for Iron (Metallbeläggningar som Korrosionsskydd paa Järn). SVEN BRENNERT. *Teknisk Tidskrift*, Vol. 64, May 12, 1934. (Section Bergvetenskap) pages 33-36. To obtain a good picture of the corrosion phenomena caused by a certain deposited metal a small surface of the base metal is connected electrically with a large surface of the metal deposit, and the current flowing through the couple is measured when submerged in the solution the corrosive action of which is to be determined. Care should be taken that the experimental conditions resemble as far as possible the actual conditions. Exaggerated conditions to obtain rapid determinations (accelerated results) are generally unreliable. BHS (13)

The Protective Value of Electroplated Metal Coatings on Steel. *Metal Industry*, N. Y., Vol. 31, Feb. 1933, pages 58-60. Progress report of Joint Inspection Committee, American Electroplaters' Society, American Society for Testing Materials, and Bureau of Standards, taken from the Quarterly Review of the American Electroplaters' Society for January, 1933. It was found that the rate of failure depended upon the character of the coating and upon the location of exposure. In general, most rapid failure occurred at Key West, Sandy Hook and Pittsburgh and least rapid at Washington and State College. Coatings containing layers of both copper and nickel have less protective value than coatings of pure nickel. If copper is employed, its use should be based on some manufacturing convenience and not on its protective value. With either pure nickel or with layers of nickel or copper nickel, good protection was not obtained unless at least 0.001" thickness was present. The presence of 0.00002" of chromium slightly decreased the protective value of thin nickel coatings but increased the value of copper nickel coatings. The conditions under which copper or nickel was deposited have no marked effect on the protective value of the coating. Although a layer of zinc or cadmium before the nickel sometimes increased the resistance to corrosion of steel, such metals have a tendency to cause white stains and blisters, especially when exposed to severe conditions. The ferroxyl and salt spray tests appear to be the most promising accelerated tests for nickel and chromium coatings. PRK (13)

Deterioration of Structures in Sea Water. *Engineer*, Vol. 157, Mar. 23, 1934, page 302; *Engineering*, Vol. 137, Mar. 23, 1934, page 352. From the Introduction to the 14th (Interim) Report of the Committee of the Institution of Civil Engineers. Gives results published by J. NEWTON FRIEND on the tests made on the last of the iron and steel test bars exposed for 10 years. LFM (13)

Cathodic Protection of Underground Pipe Lines from Soil Corrosion. ROBERT J. KUHN. *Proceedings American Petroleum Institute*, Vol. 14 (IV), 1933, pages 153-165. 18 references. "Cathodic protection" is a term applied to the method of protecting underground or submerged metallic structures from corrosion by the use of a negative electrical potential from some external source impressed on the protected structure. Subject is discussed based on the author's experiences. Items covered are theory; fundamental factors affecting cathodic-protection method as applied to underground pipe lines such as dependence on location, electrical continuity of pipe line, value of high electrical resistance of pipe line to earth, methods of increasing such resistance, electrical conditions affecting coated, insulated pipe line, installation of cathodic protection; methods of determining electrical conditions on a cathodically-protected pipe line; and the history of cathodic protection. VVK (13)

Protection from Corrosion under Alternating Stresses (Korrosionsschutz bei wechselnder Beanspruchung). P. LUDWIK & J. KRYSTOF. *Mitteilungen des Technischen Versuchsamtes, Wien*, Vol. 22, 1933, pages 42-49. The influence of tap and sea-water on the endurance bending strength of steels and non-ferrous metals was investigated. The effect of protective means against corrosion, as greasing, water-soluble oils, electrolytic deposits, nitriding, and galvanizing is discussed. Nitriding is one of the best protection for steels, the bending strength (10,000,000 alternations) was about 3 times as high as in other steels. Galvanizing (hot and electrolytic) gave about 2 times better protection than in not-galvanized steels. Electrolytic galvanizing is generally superior to hot-galvanizing in contact with seawater, the latter inclines to local corrosion which lead to endurance fracture even before all the Zn has dissolved from the surface. Ha (13)

The Practical Problems of Corrosion. Part VIII. The Inhibitive Action of Certain Pigments on Rusting. K. G. LEWIS & U. R. EVANS. *Journal Society Chemical Industry*, Vol. 53, Jan. 26, 1934, pages 25T-35T. Paints can protect either (a) by mechanically excluding corrosive influences or (b) by chemically inhibiting the corrosion reaction. The present research was devoted to isolating the chemically inhibitive action of pigments and other powders under circumstances in which it was quite certain that corrosive agents were not mechanically excluded from the metal. One method was to shake a metal specimen in a tube containing pigment, water (or solution), and air (or oxygen), but no oil. Corrosion obtained was compared with that produced in similar experiments without pigment. A second method consisted in placing drops of sodium chloride solution on a painted surface carrying a single scratch so as to expose the metal; in definitely inhibitive paints, no corrosion occurred at the scratch, whereas in paints of the excluding class corrosion set in rapidly. Pigments were classified as follows. Pigments giving definite inhibition (no corrosion at the scratch)—litharge, red lead, zinc oxide, Blom pigment, zinc dust, zinc dust mixed with equal volume of zinc oxide. Pigments giving doubtful inhibition—lead peroxide, magnesium oxide, magnesium basic carbonate, manganese dioxide, manganese dioxide (precipitated). Pigments allowing definite corrosion at the scratch—ferric oxide (pure, natural haematite, alkaline, Venetian red, indian red), arsenious oxide, antimony oxide, stannic oxide, titanium oxide, emery flour, carborundum No. 3F, lead oxalate, lead sulphate, white lead, lead chromate, barium sulphate, graphite, lampblack, aluminium pigment, aluminium coarse powder. Results indicate that the inhibitive action of pigments rests on the same principles as inhibition by soluble chemicals used in water treatment (such as sodium hydroxide or potassium chromate). When the products of incipient corrosion are precipitated in physical contact with the metal, the attack stifles itself (sometimes before it produces any visible change) and the metal remains immune. VVK (13)

APPLICATIONS OF METALS & ALLOYS (14)

Steel-Cored Aluminum Conductors for Transmission Lines. J. S. & W. E. HIGHFIELD. *Engineer*, Vol. 157, Mar. 9, 1934, pages 256-257. Owing to the different physical characteristics of steel and aluminum, the effect of temperature during erection is important. In a line properly erected, the elastic limit of neither the aluminum nor the steel must ever be exceeded. Tables show the calculated total tension loading in the whole conductor and the division of the loading as between steel and aluminum when the conductor is erected at 122°, 40° and 22° F. The subsequent changes in temperatures and loadings are also shown. For the 0.175 in.² conductor, if erected at 40° F. with a tension of 3340 lbs. the elastic limit of the aluminum may be slightly exceeded at the lowest temperature. It is exceeded if erected at 122° F. For the 0.15 in.² conductor the elastic limit of the aluminum is not exceeded if the total tension is not above 40° F. For the 0.10 in.² conductor the elastic limit of the aluminum is just exceeded under the maximum loading of ice and wind, if erected at 40° F. and a total tension of 1500 lbs. but is considerably exceeded if erected at 122° F. The factor of vibration is important in the safety of a conductor but not so important as that of tension. LFM (14)

Non-Ferrous (14a)

G. L. CRAIG, SECTION EDITOR

The Shell Construction. A Novel Light Metal Airplane Construction Method (Die Schalenbauweise. Eine neue Leichtmetall-Flugzeugbauweise.—La construction en «corps creux». Un nouveau système de construction pour les avions métalliques). A. VON ZEERLEDER. *L'Allégement dans les Transports*, Vol. 3, Jan./Feb. 1934, pages 2-4. In German and French. The utilization of light metal alloys for wings and fuselage resulted in new airplane construction methods. The metal skin replacing the formerly employed fabric material is also used to bear part of the stresses. Savings in weight of 27% are claimed in addition to gain in strength and space inside of the airplane. EF (14a)

Temperature Measurements With Tungsten-Molybdenum Thermo-Couples (Temperatur Messungen mit Wolfram-Molybdän-Thermoelementen). B. OSANN & F. SCHRÖDER. *Gesundheits-Ingenieur*, Vol. 57, Mar. 17, 1934, pages 147-148. W-Mo thermo-elements are cheaper than the commonly used Pt-Pt/Rh couples and are applicable to higher temperatures as prevail in open hearth furnaces. But much is left to be desired in regard to the development of adequate protection tubes since the use of bare wires proved to be a failure. WH (14a)

Cracking with Liquid Metal as Heat Medium (Kracken mittels flüssigen Metall als Hitzeüberträger). ALFRED OBERLE. *Petroleum*, Vol. 29, No. 25, 1933, pages 1-2. Describes at length a method of cracking oil whereby the heat is introduced through the agency of liquid metals, preferably Hg. EF (14a)

Wind Instruments Require Various Metals and Alloys. MARJORIE M. RUD. *Metal Progress*, Vol. 26, July 1934, pages 41-44. Descriptive. WLC (14a)

Aluminum in the Heads of Automobile Motors (L'alluminio nelle teste dei cilindri per motori d'automobile). G. PIANTANIDA. *Alluminio*, Vol. 3, Mar./Apr. 1934, pages 64-67. Attention is called to the increasing use of Al alloys, for cylinder heads, in both straight, and V-type motors. AWC (14a)

Low Weight Cable Cars (Leichtfahrzeuge der Standseilbahn Schwyz-Stoos.-Voitures légères du funiculaire de Schwyz au Stoos). M. KOENIG. *L'Allégement dans les Transports*, Vol. 3, Jan./Feb. 1934, pages 5-9. In German and French. The following alloys were utilized for the construction of passenger cars:

	Anticorodal (hard)	Aluman (hard)
Brinell hardness in kg./mm.²	90-100	50-60
Tensile strength in kg./mm.²	32-36	19-23
Elongation in %	11-14	3-6
Yield point in kg./mm.²	27-30	18-22

Aluman contains 1.5% Mn. The as-rolled sheets are stable in the atmosphere without paint. The joints are riveted and based on a safety factor of 7. The specific weight/passenger is 43 kg. as compared with 54 kg. for the "most recent light-steel design." The total savings in weight thus amount to half a ton/car. EF (14a)

Heavy Bridge Floor Replaced with Aluminum. J. P. GROWDON, Ross M. RIEGEL & R. L. TEMPLIN. *Civil Engineering*, Vol. 4, 1934, pages 113-117. Replacement of steel and wood floor of Smithfield Street bridge, Pittsburgh, Pa. with a battle-deck floor of Al alloy plates on Al alloy girders. The total weight of Al alloy used was 340 tons. JCC (14a)

Aluminum Electric Transmission Cable. F. READE DALLYE. *Wire & Wire Products*, Vol. 9, June 1934, pages 171-173, 189. The development of stranded Al transmission cable and the processes of manufacturing are described. Ha (14a)

New Requirements for Copper Alloy Tubes. D. K. CRAMPTON. *Metal Progress*, Vol. 25, June 1934, pages 20-24. Discussion of application of copper alloy tubing to plumbing. Corrosive action of waters differ considerably according to sources. Deep well water is more corrosive than surface water, hardness of water and treatment to remove this condition affect corrosive action. Softening treatment, filtration and aeration all tend to make the water more corrosive. Use of alum in treatment lowers pH value and increases solubility for CO_2 thus making the water more corrosive. High zinc brasses gave satisfactory service with less corrosive waters and with cold water. Dezincification and local corrosion sometimes leads to premature failures with this type of alloy. Red brass, 85% Cu and 15% Zn, gives the best service in all waters both hot and cold. Pure Cu tubing is being used with compression joints in soft tubing and soldered sleeve joints in hard drawn tubing. The flexibility of soft Cu tubing is a distinct advantage especially in refrigeration. Cu-Ni alloys, 70-80% Cu and 30-20% Ni are used for condenser tubing. These alloys resist waterline attack and O_2 concentration cell corrosion. A Cu-Ni-Al (92,4,4%) bronze has good resistance to waters, even sea water. Bright annealing of such tubing must be conducted in an atmosphere containing no S. WLC (14a)

The Manufacture of Copper Firebox Plates—Discussion. *Journal of the Institution of Locomotive Engineers*, Vol. 24, Jan.-Feb. 1934, pages 128-141. Discussion in Perth, Western Australia, of paper by W. F. Brazener. In reply to suggestions that copper supplied before the war was superior to the present product, a specification change raising the purity from 99.0 to 99.2% copper was noted, but attention was also drawn to the greater severity of present-day service and to the absence of any difference in mechanical test results. Shop practice in handling firebox plates was discussed. JCC (14a)

Chrome-Plated Copper Sheets Decorate New Exposition Building. *Steel*, Vol. 94, June 25, 1934, pages 31, 51. Ford Building, Century of Progress Exposition, employs satin finish Cr-plated Cu as the dominant note in decoration. Light reflectors are of polished Cr-plated rolled Zn. MS (14a)

Progress in the Use of Elektron Metal and Hydronalium in Motor Vehicles (Fortschritte in der Anwendung von Elektronmetall und Hydronalium im Kraftwagenbau). KEINERT. *Automobiltechnische Zeitschrift*, Vol. 37, May 10, 1934, pages 250-256. The many different uses which elektron (Mg-alloy, 1.8 sp. gr.) and hydronalium (Mg-Al-alloy, 2.16 sp. gr.) find as castings, profiles, sheets, etc., in all parts of motor vehicles, are described and construction details and manufacturing methods illustrated. Ha (14a)

Ferrous (14b)

M. GENSAMER, SECTION EDITOR

Special Steels for Ship Building. ARTHUR LAMSLEY. *Heat Treating & Forging*, Vol. 20, May 1934, pages 222-223. Si and medium Mn steels were first alloy steels used in ship construction. As corrosion is main problem faced by the ship-builder, high-Cr and Ni-Cr steels are being used more extensively for ship and yacht construction. One such steel contains 30-36% Ni. Certain types of alloy steel, notably Mn steel, are used because of their non-magnetic properties. MS (14b)

Grey-Iron Castings for Laundry Machinery. J. LONGDEN. *Foundry Trade Journal*, Vol. 49, Nov. 23, 1933, pages 293-296; Nov. 30, 1933, pages 307-308, 314. Conditions of service of these machines are dealt with in some detail, and the characteristics of irons suitable for meeting those conditions are discussed. Some attention is paid to the shrinkage phenomena met with in laundry machinery castings and to the manufacture of rollers, and pneumatic press and washing machinery castings. OWE (14b)

Cast Crankshafts (Gegossene Kurbelwellen). TH. H. WICKENDEN. *Automobiltechnische Zeitschrift*, Vol. 37, Jan. 10, 1934, pages 11-12. **Cast Iron Crankshafts.** *Automobile Engineer*, Vol. 23, Nov. 1933, pages 419-420. It was investigated how a cast iron with martensitic structure (2.25-2.5% C, 1.0-1.5% Si, 3-4% Ni) would behave in a crankshaft. As this material is very hard and can not be machined when cast it is first annealed; it can then be machined and has a hardness of 300 Brinell. Comparative fatigue tests were made which showed for S.A.E.-steel 1045, quenched and drawn, with a tensile strength of 66.5-70 kg./mm.,² an endurance strength of 33.6-35 kg./mm.,² that is a ratio of about one half; its ball pressure hardness is 200 kg./mm.² The special cast iron had a tensile strength of 42 kg./mm.,² elongation 1-2%, the endurance strength was 21 kg./mm.² and more, that is also a ratio of 50%. The elasticity moduli of the 2 materials were 2,100,000 kg./cm.² and 1,680,000 resp. Increase of stresses by notches or inclusions had much less effect on the cast iron, and of particular value is its high damping effect. While crankshafts are not yet made of this material, camshafts are already used extensively of a cast iron of 2.8% C, 2.0% Si, 0.75% Ni, 0.20% Cr, 0.75% Mo. They have shown very good wearing qualities. RHP+Ha (14b)

Stainless Steels and Their Use in Chemical Industry (Les Aciers Inoxydables et leur Emploi dans l'Industrie Chimique). VIALLE. *La Technique Moderne*, Vol. 25, Feb. 1, 1933, pages 121-124. General knowledge of stainless steels is reviewed by author. First section of article deals with properties of corrosion resisting steels, in second section steels are classified. In each class of steel, best industrial uses are reviewed. In last section of article, working of these steels is dealt with in the following chapters: 1. Hot working, 2. cold working, 3. welding, 4. pickling, 5. polishing. FR (14b)

Heat and Corrosion Resistant Cast Irons Having a Wide Range of Expansion Properties. THOMAS H. WICKENDEN. *Automotive Industries*, Vol. 69, Oct. 7, 1933, pages 428-429. The application of "Ni-Resist" cast iron in the automotive industry is now well established, in a variety of uses. "Ni-Resist" is an austenitic cast iron containing approximately 14% nickel, 6% copper, and 2% chromium, Ni-Resist, with its high coefficient of expansion, has proved so useful that it was decided to investigate the possibility of producing an iron with similar resistance to heat and corrosion, but with a lower coefficient of expansion. The choice of an iron, of the proper coefficient of expansion, for use as inserts in cast iron, steel, brass, and aluminum, is of vital importance to insure life and operation. This sister material of "Ni-Resist" has been under development for several years and now has sufficient background to prove its usefulness as a valve seat insert material. This austenitic iron with Ni content in the range 28 to 30% provides an ideal coefficient of expansion for use in combination either with a carbon steel or plain iron base. With 4% Cr this iron will have 140 to 160 Brinell and machine easily. 5% Cr raises hardness 20 points Brinell but machining becomes more difficult. For cylinder liners a range of 4 to 5% Cr is recommended, while for valve seat inserts 5 to 6% Cr may be used. DTR (14b)

Manufacturing Safety Razor Blades. R. W. WOODWARD. *Iron Age*, Vol. 131, May 25, 1933, pages 811-813. **Testing Safety Razor Blades.** June 22, 1933, pages 981-983, adv. sec. page 14. Large part of strip steel used for making razor blades is from Sweden or Germany. Composition of the steel is about 1.20-1.35% C and less than 0.30% Cr. American steel contains 0.50% or more Cr. Special alloy steels are used by some manufacturers for greater corrosion resistance. Inspection includes the visual, chemical, hardness, bend and magnetic testing. Sharpening operation includes grinding, honing and stropping. In second installment describes the various tests, other than routine inspection in studying finished blades. Includes information on failure and care of blades. VSP (14b)

Selecting and Buying the Right Steel for the Part. FRANK J. ALLEN. *Metal Progress*, Vol. 26, July 1934, pages 28-32. Discussion of the methods of selection and control of quality of steels purchased. WLC (14b)

Heat-Resisting Cast Iron in Aluminum Die-Casting Foundries. *Foundry Trade Journal*, Vol. 49, Dec. 7, 1933, page 330. Article emphasizing the value of Nicrosilal in the manufacture of dies used in the production of aluminium die-castings. OWE (14b)

Automatic Crossing Guard a Potential Tonnage Market. EDWARD A. FRANCE, JR. *Steel*, Vol. 94, June 25, 1934, pages 32-33. Manufacturers are perfecting a railroad crossing guard, which is in the form of a steel box placed beneath the roadway, one on either side of a grade crossing. A 12-in. high steel obstruction, with concave face, is raised by a motor and spring arrangement, actuated by an approaching train through electrical contact with the rails. MS (14b)

Alloy Cast Irons in Automobile Construction. A. B. EVEREST. *Iron & Steel Industry & British Foundryman*, Vol. 6, Mar. 1933, pages 219-223; Apr. 1933, pages 255-256. See *Metals & Alloys*, Vol. 4, Oct. 1933, page MA 319. CHL (14b)

Modern Metals Used in Household Devices. E. J. ESNER. *Metal Progress*, Vol. 25, June 1934, pages 43-46. Describes methods and materials used in production of wringerless domestic washer. Washer top of Al casting made in permanent mold is feature. Gear cutting and heat treatment methods using S.A.E. 1315X carburizing steel are described. WLC (14b)

Special Nickel Alloys (Spezial Nickellegierungen). *Die Metallbörse*, Vol. 23, Aug. 19, 1933, pages 1053-1054; Aug. 26, 1933, pages 1085-1086; Sept. 2, 1933, pages 1117-1118; Sept. 9, 1933, pages 1149-1150. In continuation of previous publication on commercial Al alloys (See *Metals & Alloys*, Vol. 4, May 1933, pages MA 133) brasses and bronzes (See *Metals & Alloys*, Vol. 5, Apr. 1934, page MA 157) the trade names of some 201 Ni alloys are compiled and 311 analyses and analysis ranges respectively of Ni alloys on the market are presented. The author lists as Ni alloys only those alloys in which Ni represents the characteristic element, i.e. alloys above 10% Ni and "alloy groups characterized by their Ni-content" as for instance German Silver. In many cases the principal utilization is mentioned in the 123 foot-notes. EF (14b)

Large Uses of Steel in Small Ways. No. 263. Chipping Hammers. *Steel*, Vol. 94, June 18, 1934, page 46. Manufacture of pneumatic chipping hammers requires more than 100 tons of alloy steel annually, principally bars and forgings. MS (14b)

GENERAL (15)

RICHARD RIMBACH, SECTION EDITOR

1 **General Metallurgy (Allgemeine Metallkunde).** E. PIWOWARSKY. Verlag Gebrüder Borntraeger, Berlin, 1934. Paper, 6½ x 9½ inches, 248 pages. Price 14.4 RM.

An elementary text book dealing with principles exemplified by various ferrous and non-ferrous alloys. To cover so wide a field with any degree of sufficiency in so small a compass is quite a task, which has been rather well accomplished. Beside the usual discussion of equilibrium diagrams and other standard material in such books, recent information and modern points of view on such matters as atomic structure, precipitation hardening, nitriding and so on, are featured. Paper, printing and illustrations are good. H. W. Gillett (15)—B—

2 **Report for the year 1933, National Physical Laboratory.** Published by H. M. Stationery Office, London. Paper, 8" x 10"¼, 269 pages. Price 13 s.

The activities of the Metallurgy Department of the N. P. L. headed by Dr. Desch and those of the Engineering Department, headed by Dr. Gough, both of whom are well known in this country from their visits here, are always of interest. The work of the Engineering Department is largely in fields of metallurgical engineering, especially on problems of fatigue, high temperature properties, wear, etc. The personnel of these two divisions amounts to some 140 people. Thus a very much larger staff is dealing with metallurgical problems at the N. P. L. than at the Bureau of Standards.

3 Fatigue and corrosion fatigue work on single crystals, effect of surface conditions in fatigue, effect of combined loading in fatigue, cracking of boiler plate, strength of welds, viscosity and surface tension of molten tin, aluminum alloys, oxides in steel, impurities in copper, and dental amalgams are among the subjects being studied.

Interesting points mentioned are that stainless steel journals in bearings that should have full fluid lubrication show higher friction than carbon steel, that comparison of long time creep tests and Pomp's accelerated tests are under way, that carbon steels of similar composition may vary considerably in creep properties, that high purity irons of apparently the same degree of purity show different temperatures for A_3, that corrosion fatigue tests of beryllium bronze are in progress and that electron diffraction methods are being adopted for study of the initial film formed in oxidation of metals. H. W. Gillett (15)—B—

4 **Electrokinetic Phenomena and Their Application to Biology and Medicine.** HAROLD A. ABRAMSON. Chemical Catalog Co., Inc., New York, 1934. Cloth, 6¼ x 9¼ inches, 331 pages. Price $7.50. The only previous text on electrokinetics is in German by Prausnitz and Reitstötter, entitled, "Elektrophorese, Elektroosmose, Elektrodialyse," dealing very little with electrokinetic theory and mainly with its applications. Abramson's volume is the first to adequately discuss the theory in English, with all due respect to the reviews published in the annual colloid symposia, physicochemical journals and texts on colloids. The volume is one of the American Chemical Society monograph series. More than half is theory and the remainder discusses applications in biology and medicine, fields where this branch of colloid science has proven a powerful tool. The application to other fields of applied science is not discussed, but this is a task on which the reviewer has been engaged for over a year. Dedication of the volume to M. S. Smoluchowski, one of the important developers of electrokinetic theory is appropriate.

5 Readers of this journal will find the half of the book on theory and description of phenomena of value. Electrokinetics includes all cases where the double electric layer formed at phase interfaces causes important phenomena,—electrophoretic migration of suspended particles, electrosmotic transfer of liquids through membranes or beds of broken solids, electrodialytic purification of liquids and solids, streaming potentials through capillaries, peptization, flocculation and sedimentation of suspensions. A comprehensive treatment in English of the applications of these phenomena to clay technology, soil science, flotation, concentration of minerals, purification of water, fruit juices, etc., yet remains to be written. Oliver C. Ralston (15)—B—

6 **Report of Committee on Manual on Presentation of Data (1933) (Appendix to Report of Committee E-1 on Methods of Testing).** H. F. DODGE, Chairman. *Proceedings American Society Testing Materials*, Vol. 33, Pt. I, 1933, pages 451-488. This manual discusses statistical methods and the application of such methods to the problem of (a) condensing the information contained in a set of observations, and (b) presenting the essential information in a concise form more readily interpretable than the unorganized mass of original data. VVK (15)

7 **Planning for the Collection of Standardization Data.** J. R. TOWNSEND. *Proceedings American Society Testing Materials*, Vol. 33, Pt. 2, 1933, pages 770-785. Two engineering investigations leading to standardization by the Society are given as illustrative of fundamental considerations comprising careful consideration of the problem and all the factors involved, classification of variables as to their relative importance, use of simple but adequate methods of test, and the use of statistical methods. VVK (15)

Ontario Research Foundation—Report for the Year 1933. Published 1934, 33 pages. Two pages are devoted to the work of the Department of Metallurgy. A systematic study of white cast iron is in progress. Work on fractional volatilization of chlorides of Au, Ni, Cu and Fe is soon to be published. Influence of cooling rate on structure of carbon steel is being investigated. HWG (15)

8 **Corby Steel Works.** *Electrical Review*, Vol. 114, Apr. 13, 1934, pages 513, 515-516. Describes supply of electric energy from a public utility source to the works of Messrs. Stewarts & Lloyds, Ltd., at Corby, Northants, Eng. Plant is integrated for the conversion of Fe ore mined in the vicinity into finished steel tubes. All sections from ore excavation to tube plant are electrically operated. MS (15)

Ohio Brass Co. Keeps Plant Clean. FRANK G. STEINEBACH. *Foundry*, Vol. 61, Nov. 1933, pages 10-12, 42, 45. Careful planning of good housekeeping in all departments of the Ohio Brass Co. is described. VSP (15)

The Place of Metallurgists in Industry. JAMES ASTON. *Iron Age*, Vol. 132, Nov. 23, 1933, pages 20-21, 51. From a paper presented before the Society for the Promotion of Engineering Education. Reviews the growth of industrial metallurgy and concurrent expansion and improvement of manufacturing processes. VSP (15)

9 **High Temperatures (Les Hautes Températures).** HENRY LE CHATELIER. *Revue de la Soudure Autogéne*, Vol. 26, Feb. 1934, pages 4-5. Short history of author's researches on temperature measuring apparatus with thermo-couples and monochromatic radiation pyrometers and about his studies on temperature of C_2H_2-O flame and industrial applications of C_2H_2. FR (15)

High Speed Travel Requires New Cars and Engines. E. E. THUM. *Metal Progress*, Vol. 25, April 1934, pages 17-22. Comments on present transportation trends. WLC (15)

10 **Use of Dry Ice in the Metal Industry (Verwendung von Trockeneis in der Metallindustrie).** *Montanistische Rundschau*, Vol. 26, May 16, 1934 (Section *Stahlbau-Technik*), pages 6-7. Discusses the use of dry ice in the heat-treatment of metals; for shrinking small parts prior to assembling to insure tight fit; and to prevent explosions in the welding of tanks containing combustible liquids. BHS (15)

Definition of Alloy Steels. HANS DIERGARTEN. *Metal Progress*, Vol. 24 Nov. 1933, pages 44-45. Described efforts of German industry to classify its steels. 15

Research Pays Profits. H. W. GILLETT. *Metals & Alloys*, Vol. 5, Feb. 1934, pages 23-27. The author discusses the economic and planning aspects of research projects referring to a number of such studies as hard spots in Al castings, Si-Mn alloy from low grade ore, Fe-U, Mn-Mo steel, electric brass melting, Al-coated duralumin, rubber bonded cores, and the prevention of embrittlement in galvanizing structural steel. 17 references. WLC (15)

Some Principles of Industrial Research. H. A. SCHWARTZ. *Metals & Alloys*, Vol. 5, Mar. 1934, pages 4953. It is shown that circumstances affect the methods of research. WLC (15)

Economic (15a)

The Best Year for Gold and the Worst for Silver. SCOTT TURNER. *Mining & Metallurgy*, Vol. 14, Jan. 1933, pages 4-6. The closing year has been the best for Au and the worst for Ag in many decades. There are good reasons for believing that the Au industry will be able to maintain its improved position, while increased activity in Au promises well for the future stabilization of Ag mining industry. VSP (15a)

Silvery Iron. A. H. DIERKER. *Engineering Experiment Station News*, Ohio State University, Vol. 6, Apr. 1934, pages 2-3. Brief account of silvery iron industry at Jackson, O. HWG (15a)

Italian Industries To Be Under More Strict Control. GUIDO VANZETTI. *Steel*, Vol. 94, Jan. 1, 1934, pages 172, 174. Review of iron and steel trade in 1933. MS (15a)

The Italian Foundry Industry in 1933. GUIDO VANZETTI. *Foundry Trade Journal*, Vol. 50, Jan. 18, 1934, page 46. Vanzetti discusses conditions in Italy during 1933, pointing out in particular that production is slightly below that of 1932, though with some indications of improvement in the latter part of the year. OWE (15a)

The French Foundry Industry. MAURICE OLIVIER. *Foundry Trade Journal*, Vol. 50, Jan. 18, 1934, pages 46, 55. Olivier discusses very briefly the situation in the French foundry industry during 1933, emphasizing the fact that a grave crisis is being encountered, which necessitates a new policy. OWE (15a)

The British Steel Foundry Industry in 1933. ROBT. HADFIELD. *Foundry Trade Journal*, Vol. 50, Jan. 18, 1934, pages 35-36. Discussion of the situation in the British steel foundry industry in 1933, in which very definite improvement in the industry is indicated by a number of statistics. OWE (15a)

Czecho-Slovakian Foundry Industry in 1933. M. FRANT PISEK. *Foundry Trade Journal*, Vol. 50, Jan. 18, 1934, page 55. A discussion of the Czecho-Slovakian foundry industry in 1933. OWE (15a)

The German Foundry Industry in 1933. TH. GEILENKIRCHEN. *Foundry Trade Journal*, Vol. 50, Jan. 18, 1934, page 56. A discussion of conditions in the German foundry industry during 1933. OWE (15a)

The Nickel Industry in 1933. *Foundry Trade Journal*, Vol. 50, Jan. 18, 1934, page 64. Article dealing with the uses to which nickel is being put throughout the world, and pointing out the increasing popularity of nickel for coinage and the uses to which Monel metal is being put. Attention is directed to the employment of nickel in ferrous and non-ferrous metallurgy, and particularly to the remarkable progress made in the manufacture of stainless steel. The article closes with reference to 3 special alloys—Ni-Resist, Ni-Hard, and Ni-Tensyliron. OWE (15a)

The American Foundry Industry in 1933. DAN AVEY. *Foundry Trade Journal*, Vol. 50, Jan. 18, 1934, page 54. A discussion of conditions and technical developments in the American foundry industry in 1933. OWE (15a)

The British Malleable Foundry Industry in 1933. C. A. LINDOP. *Foundry Trade Journal*, Vol. 50, Jan. 18, 1934, page 36. Brief outline. OWE (15a)

The Austrian Foundry Trade. STEFAN LEEB. *Foundry Trade Journal*, Vol. 50, Jan. 18, 1934, pages 59-60. Discussion of conditions in the Austrian foundry industry during 1933. OWE (15a)

Manganese Ore and Ferro-Manganese in 1933 (Minerai de manganese et ferro-manganèse en 1933). *Journal du Four Electrique*, Vol. 43, Apr. 1934, pages 128-129. Five major consuming nations imported in 1934 altogether 1,100,000 tons of manganese ore, the major part of which came from Russia. The decline of price of it stopped in all producing countries except Russia. Its cif price of 8 pence per unit must be below the production costs. JDG (15a)

Magnesium Industry in 1933—Advance Summary. A. E. DAVIS. *United States Bureau of Mines, Mineral Market Reports* No. M. M. S. 287, May 24, 1934, 2 pages. Mg ingot sold or used in the U. S. in 1933 was 1,434,893 lbs. valued at $377,181, an increase of 81% in quantity and 65% in value over 1932. Imports decreased. AHE (15a)

The Metal Industries. **Copper** by WILLIAM G. SCHNEIDER; **Zinc** by JULIAN D. CONOVER; **Tin** by C. L. MANTELL; **Aluminum** by S. K. COLBY; **Lead** by F. E. WORMSER; **Nickel and Its Alloys** by ROBERT G. STANLEY; **Platinum** by CHARLES ENGELHARD; **Gold and Silver** by G. H. NIEMEYER; **Secondary Metals** by THOMAS A. WRIGHT; **The Brass Foundry** by H. M. ST. JOHN; **The Brass Rolling Mills** by WILLIAM J. PETTIS; **Plating and Finishing** by A. K. GRAHAM; **Jewelry Making** by C. M. HOKE. *Metal Industry*, N. Y., Vol. 32, Jan. 1934, pages 2-9. A symposium of the records made in 1933 and prospects for 1934. PRK (15a)

Greater Diversity of Materials Aid Recovery; A Review of Developments in 1933. HERBERT R. SIMONDS. *Iron Age*, Vol. 133, Jan. 4, 1934, pages 68-74, 77. Review of the progress made in the metal working industries in 1933. The developments are covered under the following headings: Steel, alloys, castings, forgings, die castings, stampings, Al, Cu, Zn, other non-ferrous metals, transportation, and products and machine elements. VSP (15a)

Statistical Review of Ontario's Mineral Industry in 1932. W. R. ROGERS & A. C. YOUNG. *Ontario Department of Mines, 42nd Annual Report*, Vol. 42, Part 1, 1933, pages 1-49. Statistical. AHE (15a)

Co-operation Is Key to Scrap Problems Under New Deal. BENJAMIN SCHWARTZ. *Steel*, Vol. 94, Jan. 1, 1934, pages 109-110. Discusses some difficulties confronting the scrap industry and gives suggestions for their solution. Holds that direct dealing between steel mills and their customers for the latter's scrap is inimical to the best interests of the steel industry. MS (15a)

Iron and Steel Industry in 1933—Advance Summary. H. W. DAVIS. *United States Bureau of Mines, Mineral Market Reports*, No. M.M.S. 281, May 10, 1934, 6 pages. In 1933, Fe ore mined in the U. S. was 17,553,188 tons, 78% over 1932, but 63% below the av. for the preceding 5 yrs. Shipments increased 362% to 24,624,285 tons, 46% below the 1928-32 av. Stocks decreased 38%. Production of Pig Fe in 1933 was 13,027,343 tons, 52% more than 1932 and 52% less than the 5 yr. av. Production of ferro alloys was 348,894 tons, an increase of 51%. AHE (15a)

Tin in 1933. E. BALIOL SCOTT. *Mining Journal, Annual Review No.*, Vol. 184, Feb. 17, 1934, pages 7-9. Demand for Sn exceeded production (87,431 tons) and price advanced. Stocks were reduced from 55,903 to 29,135 tons. AHE (15a)

Problems of Non-Ferrous Metallurgy in 1933. D. I. STEINBOCK. *Tzvetnuie Metallui*, No. 2-3, March-April, 1933, pages 5-14; No. 4, May 1933, pages 12-23. Summarizes the program of development of Russian non-ferrous industry for 1933. This program includes (1) improvement of quality of product, plant efficiency, recovery of metals, and lowering the production costs, (2) the completion of plants and smelters now under construction, and (3) exploration of new non-ferrous mineral deposits and construction of new plants. Points out the attainments and the failures of the five year plan, and describes the program for production of Au, Pb, Zn, Al, Ni, Sn and other metals in 1933. BND (15a)

Mining Taxation in the Lake Superior District. CLARENCE B. RANDALL. *Yearbook American Iron & Steel Institute*, 1932, pages 40-58. See *Metals & Alloys*, Vol. 4, July 1933, page MA 228. VVK (15a)

Molybdenum Industry in 1933—Advance Summary. FRANK L. HESS & H. W. DAVIS. *United States Bureau of Mines, Mineral Market Reports*, No. M.M.S. 277, May 2, 1934, 2 pages. Mine production of Mo ore in the United States in 1933 was 705,000 short tons which yielded 5,348 tons of concentrates carrying 5,627,700 lbs. of metallic Mo, compared with 363,400 tons of ore, 2,387 tons of concentrates and 2,431,000 lbs. of Mo in 1932. AHE (15a)

Some Aspects of the Luxemburg Iron Industry. K. C. EDWARDS. *Engineering*, Vol. 136, Nov. 17, 1933, page 552. See *Metals & Alloys*, Vol. 5, May 1934, page MA 239. LFM (15a)

Ferromanganese for Export. B. M. SUSLOV. *Metal Progress*, Vol. 24, Nov. 1933, pages 47-48. Account of ore and facilities available in U.S.S.R. for the production of exportable Fe-M. WLC (15a)

Ferromanganese and Spiegel from Electric Furnaces. B. M. SUSLOV. *Metal Progress*, Vol. 24, Oct. 1933, page 56. A survey of the production of ferro-alloys in U.S.S.R. Electric furnaces are being used exclusively for the production of ferromanganese. Melting equipment consists of French Miguet-Perron furnaces. WLC (15a)

Manganese Ore Industry in 1933—Advance Summary. H. W. DAVIS. *United States Bureau of Mines, Mineral Market Reports* No. M. M. S. 282, May 11, 1934, 5 pages. Shipments of domestic Mn ore (35% or more Mn) in 1933, consisted of 9,527 long tons of metallurgical ore, 7,904 tons of battery ore, and 1,127 tons of miscellaneous ore. This is a decline in metallurgical and a gain in total ore. Mont. supplied 49% and Va. 26% of shipments. Imports increased from 53,553 long tons of contained Mn in 1932 to 79,391 tons in 1933. AHE (15a)

List of Exhibitors

(Continued from page A14)

Vanadium Corp. of America, New York, N. Y. Booth 335.
Exhibiting: Elliptic and coil springs of chrome vanadium and silicon vanadium steel; manganese vanadium structural steel, plates and shapes, bend tests, and welded tests of this steel; specimens of manganese chrome vanadium steel (Normalloy); vanadium steel castings; chrome vanadium steel articles, such as gears, dies and tools. See advertisement in this issue on page A21.

Vapofier Corp., Chicago, Ill. Booth 258.
Exhibiting: Oil burners; manifold pressure gage. See advertisement in this issue on page A51.

Victor Saw Works, Inc., Middletown, N. Y. Booth 384.
Exhibiting: Molybdenum steel hack saws.

Waterbury Farrel Foundry & Machine Co., Waterbury, Conn. Booth 456.
Exhibiting: Wire drawing machinery.

Welding Engineer, Chicago, Ill. Booth 256.
Exhibiting: Publications.

Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. Booths 436 and 479.
Exhibiting: Electric heat treating furnaces; electric welding machines; 75 kv-a. motor operated spot welder with Ignitron weld timer; 500 ampere a. c. welder in operation; a 300 ampere d. c. welder also in operation; a 300 ampere engine driven welder.

Wheelock, Lovejoy & So., Inc., Cambridge, Mass. Booth 386.
Exhibiting: Machine parts made from Hy-Ten, Economo and special analysis steels.

Wickwire Spencer Steel Co., New York, N. Y. Booth 138.
Exhibiting: Wissco metal conveyor belt display; Wissco wire and springs particularly adapted to the requirements of the automotive and allied industries. These will include stainless steel, black oil tempered, valve spring steel, music, shaped, machinery spring and rope wire, together with a complete range of springs and formed wires.

Wilson Mechanical Instrument Co., New York, N. Y. Booth 326.
Exhibiting: "ROCKWELL" hardness tester; Smith-Taber stiffness tester. See advertisement in this issue on page A62.

Wilson Welder & Metals Co., Inc., New York, N. Y. Booth 378.
Exhibiting: Electric welding machines.

Youngstown Sheet & Tube Co., Youngstown, O. Booth 498.
Exhibiting: Sheet; tubes; wire; alloy steels.

Zeiss, Inc., Carl, New York, N. Y. Booth 397.
Exhibiting: Microscopes, spectroscopes; magnifiers; precision measuring instruments. See advertisement in this issue on page A67.

Historical (15b)

Romantic Copper Its Lure and Lore. IRA B. JORALEMON. D. Appleton-Century Co., New York, 1934. Cloth, 5½ x 8 inches, 294 pages. Price $3.00.

Written by a mining engineer who has himself seen many of the world's copper mines and who knows how to write interestingly, this story of the history and romance of the finding and mining of copper is fascinating to the general reader, doubly so to the metallurgist.

How much chance has played in the development of copper, and how huge are the stakes with which this gigantic gambling game has been played, ten million dollars being but chicken feed in the outfitting of a big mine, are most interestingly brought out.

Sometimes a book reviewer can leaf through a volume and appraise it without close reading. But this one wouldn't let itself be handled that way, it kept us up long beyond our proper bed time. H. W. Gillett (15b)—B—

An Old Naval Foundry : Indret (Une Vieille Fonderie de la Marine : Indret) MOUTARD. *La Fonte*, Vol. 3, July-Aug.-Sept. 1933, pages 303-319. Second part of the story from 1827 up to 1933, of the old French naval foundry which has been replaced by a new one, description of which is given. FR (15b)

Origin of the Oldest Iron and Steel (Die Herkunft des ältesten Eisens und Stahls) HEINRICH QUIRING. *Forschungen und Fortschritte*, Vol. 9, Mar. 20, 1934, pages 126-127. Historically reviews the findings on Fe and steel between 4000 and 800 B. C. and arrives at the conclusion that the first commercial production of wrought Fe from hematite and hardening in a charcoal fire had been accomplished in Armenia at about 1400 B. C. EF (15b)

Alloy Tool Steels and the Development of High Speed Steel. ARTHUR S. TOWNSEND. *Transactions American Society for Steel Treating*, Vol. 21, Sept. 1933, pages 769-795. Traces the history of alloy tool steels from 1868-1933 with an effort to establish facts regarding certain disputed points and give credit for contributions where due. It is attempted to determine precisely what Taylor and White invented. 71 references. WLC (15b)

Bells—Their History and Manufacture. E. DENISON TAYLOR. *Edgar Allen News*, Vol. 12, Apr. 1934, pages 423-425; May 1934, pages 434-436. A history and description of old bells is given, laws of ringing of bells and carillons described. Bells are cast of Cu-Sn alloy, steel bells have not been found satisfactory. Ha (15b)

One Hundred Years of Sheet Copper. *Sheet Metal Worker*, Vol. 25, Jan. 1934, pages 21-22. Historical sketch of the industry in U. S. A. Ha (15b)

Norwegian Iron and Steel Production, Past and Present (Norsk Jern og Staalproduksjon før og nu.) GUNNAR SCHJELDERUP. *Teknisk Ukeblad*, Vol. 81, Apr. 19, 1934, pages 223-225. Paper presented before the Norwegian Polytechnic Society. Norwegian iron ore reserves 350,000,000 tons with 30-35% Fe in open pit mines, and several times this figure in shaft mines. The story of electric iron ore smelting in Norway from 1905 to date is presented. Latest development by Christiania Spigerverk started in 1923, using a furnace developed by Tysland and Hole, capacity 6,000 kv.-amp. At present this company has one furnace at Oslo producing 12,000-13,000 metric tons pig iron annually, and a 9,000 kv.-amp. furnace at Bremanger, capacity 18,000-20,000 tons annually. These are closed three-phase furnaces, with Söderberg electrodes, operating with coke, and utilizing the furnace gas for heating in the rolling mill. Slag is used for concrete. License for this furnace has been sold to three steel plants on the continent. Other developments in Norway are the Harald Pedersen process for purifying bauxite in aluminum production, with pig iron as byproduct, and the Edwin's process for gas reduction of iron which now is being tested on a large scale at Bochum, Germany. Electric steel is being produced at Stavanger Staalverk, Nes Jernverk, and Christiania Spigerverk; the latter has an annual capacity of 50,000 tons. BHS (15b)

History of the Discovery of Vanadium (Zur Entdeckungsgeschichte des Elementes Vanadium). ERNST WITTICH. *Forschungen & Fortschritte*, Vol. 9, Jan. 20, 1934, pages 38-39. Historical evidence is presented that Va had been discovered in 1802 by Andres Manuel del Rio, Professor of Mineralogy at the Mining Academy of Mexico and designated as Erynthronium. 30 years later this element was rediscovered by N. G. Sefström in Swedish Fe ores of Taberg and called vanadium. EF (15b)

An Old Foundry of the Marine-Indret (Une Vieile Fonderie de la Marine-Indret). MOUTARD. *La Fonte*, Vol. 3, Oct.-Nov.-Dec. 1933, pages 343-358. This 3d and last section of the article gives a short history of mechanical testing of gray cast Fe in the old French naval foundry which has been recently completely transformed. Following points are reviewed: Tests of machine cast Fe up to 1841. Experiments of 1843: impact test. Historical of transverse test with deflection measurements. FR (15b)

Discover Ancient Bronze in Sweden. SIXTEN O. V. NILSSON. *Foundry*, Vol. 62, May 1934, pages 24-25, 54. Excavation of small mounds indicate that it was probably a dwelling of a foundryman producing bronze castings. Illustrates and describes some of the articles excavated. Some of the thinnest castings present the highest degree of skill in application of ornamental design and in surface finish. VSP (15b)

Some Steps in Metallurgical Progress, 1908-1933. WALTER ROSENHAIN. *Engineering*, Vol. 136, Dec. 29, 1933, pages 725-728. From paper read before the Institute of Metals, Sept. 1933. See *Metals & Alloys*, Vol. 5, June 1934, page MA 303. LFM (15b)

Early English Ironworks and Foundry Development. J. PEARMAN. *Edgar Allen News*, Vol. 13, June 1934, pages 457-460. An early history of iron in Britain is given which dates back to the Romans who were the first iron workers on a large scale. The development over the Anglo-Saxon times and middle to early modern times is outlined. Ha (15b)

The Reverberatory Furnace with Coal Fuel, 1612-1712. RHYS JENKINS. *Engineer*, Vol. 157, Jan. 19, 1934, pages 81-82. From paper read before the Newcomen Society for the Study of the History of Engineering and Technology, Jan. 17, 1934. LFM (15b)

25 Years' Progress in Metallurgical Plant. W. R. BARCLAY. *Engineer*, Vol. 156, Sept. 29, 1933, pages 312-313. From lecture delivered to the Institute of Metals, Sept. 18, 1933. See *Metals & Alloys*, Vol. 5, June 1934, page MA 303. LFM (15b)

Early Roll-Founding. HAROLD E. COOKSON. *Foundry Trade Journal* Vol. 49, Nov. 2, 1933, pages 251-252. Extended abstract of Pt. 2 of an address dealing with the history of the founding of rolls. OWE (15b)

Foundry Research in 1933. F. A. FREETH. *Foundry Trade Journal*, Vol. 50, Jan. 18, 1934, pages 49-50. Article accompanied by bibliography covering papers that have been published in Great Britain—particularly by the B.C.I.R.A. —during 1933. OWE (15b)

Last Years of les Vieilles Forges du St. Maurice. *Iron and Steel of Canada*, Vol. 17, Jan.-Feb. 1934, pages 6-8. An historical article accompanied by 6 photographs dealing with the above subject, covering the years 1870-1883. OWE (15b)

The Story of Radnor Forges. *Iron & Steel of Canada*, Vol. 17, Mar.-Apr. 1934, pages 24-27. An article accompanied by 3 illustrations, and describing the charcoal iron industry of the St. Maurice valley established in 1730 and continuing until 1910. OWE (15b)

PROFESSIONAL DIRECTORY

Personal Services Only

1-Inch Card $2.00 per insertion — 2-Inch Card $4.00 per Insertion

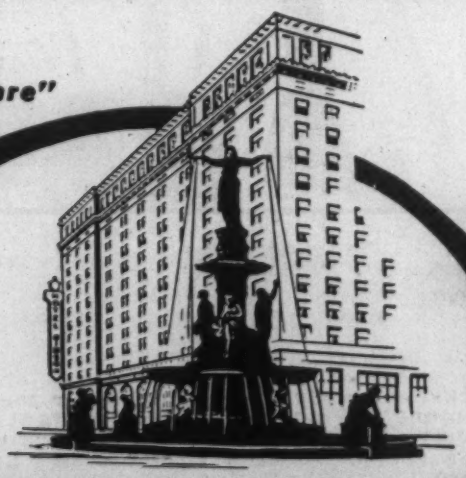
LUCIUS PITKIN, INC.
Chemists—Metallurgists—Engineers—Assayers
Consultants on Die Casting
47 FULTON STREET NEW YORK, N. Y.
Also: Buffalo Testing Laboratories, Gerrans Bldg., Buffalo, N. Y.

THE TECHNICAL TRANSLATION BUREAU
Quality Translations, Abstracts, Reviews, Surveys
POST OFFICE BOX 293 PITTSBURGH (13)

R. A. BULL
CONSULTANT ON STEEL CASTINGS
Carbon or Alloy—Electric or Open-Hearth
Large or Small—Production or Application
(Consultant and Mid-western Representative for Ajax Electrothermic Corp.)
541 DIVERSEY PARKWAY CHICAGO

METALLURGICAL ADVISORY SERVICE
Investigations Testing
Expert Photomicrography
214 DEWEY STREET PITTSBURGH (18), PA.

"On Famous Fountain Square"

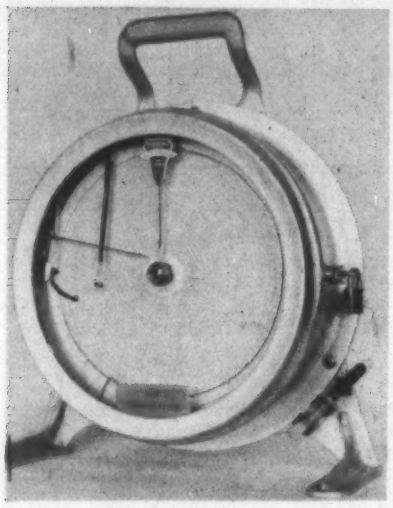


THE GIBSON WELCOMES YOU TO CINCINNATI
One thousand rooms, each with bath. 70% of all rooms at $2.50, $3, $3.50 and $4. Five famous restaurants: Florentine Room, Roof Garden, Tea Room, Coffee Shop, and Sandwich Grill. Garage Door Service. Best location in city. Cincinnati's convention headquarters.
FRANK W. PALLANT, Gen. Mgr.
The Greater HOTEL GIBSON CINCINNATI

NEW EQUIPMENT AND MATERIALS

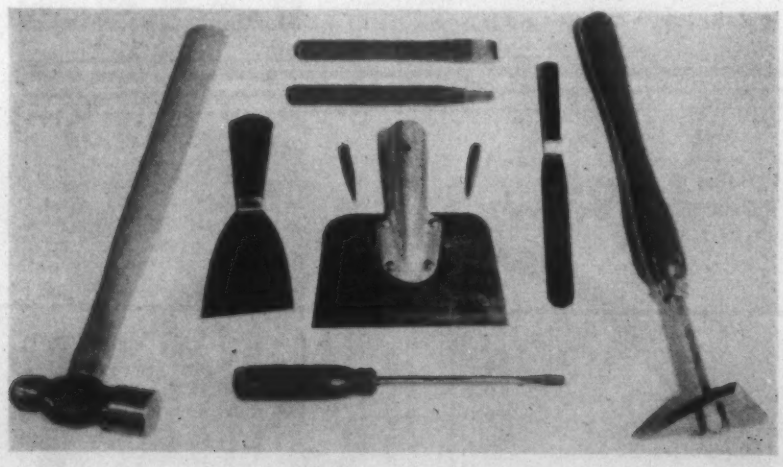
New Portable Thermometer

The Foxboro Company, Foxboro, Mass., announce a new portable recording thermometer, which is easy to carry because the handle is in line with the center of gravity of the instrument. Because of the varying requirements of industry, the Portable is furnished with either self-contained or long-distance type thermometers in 8- or 10-inch case sizes. The illustration shows a 10-inch, self-contained, Class II Instrument with a range of —25° to +125° F. A companion instrument with identically the same features may be had for recording pressures. These portable pressure recorders have been found very useful where there are a series of pressures at different spots that must be checked periodically. Each of these portables can be removed from its stand by simply unscrewing three bolts. The instruments can then be fastened on a wall or board for permanent use if so desired.



Beryllium Copper Tools

Stanley Tools, New Britain, Conn., has placed on the market a new line of non-sparkling tools made from Anaconda beryllium copper. This new alloy, which contains over 97% copper, can be hardened, toughened and strengthened by combined working and heat treating until its physical qualities exceed those of any other non-ferrous metal. Beryllium copper is non-magnetic and will not give



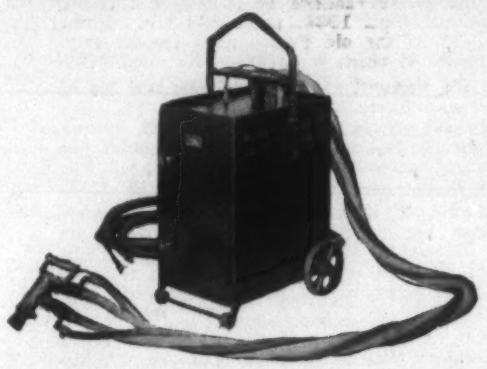
off sparks when struck against other metals or materials. It is immune to rust and highly resistant to a wide variety of corrosive agents. Stanley non-sparking beryllium copper tools are made from wrought and heat treated metal which provides them with a greater strength and toughness than tools made from cast metal. The line includes hammers, chisels, scrapers, sledges, pinch bars, screw drivers, wedges, fork tips and other items. Edged tools of this metal possess a long life and it is claimed will readily cut tough steel parts.

Permite Leaded Phosphor Bronze Bars

Permite bronze bars, manufactured by Aluminum Industries, Inc., Cincinnati, O., are available in standard six foot lengths in diameters from ⅝" to 2" by 1/16" steps. All standard bearing bronze alloys may be supplied. It gives manufacturers of screw machine products a stock of superior bearing qualities for screw machine or turret lathe production. It represents the first time that leaded bearing bronze has ever been produced in machine lengths. The stock is claimed to possess exceptionally free machining qualities. Using tungsten carbide tools, it has been successfully machined at speeds in excess of 1500 surface feet per minute, without a coolant. A turned finish has been adopted for Permite bars. The better gripping afforded with this finish makes the free machining qualities completely available without excessive strain on the checking mechanism. This exclusive finish, combined with the easy machineability of the material, will often permit production rates 50% higher than those for drawn bar stock.

New Stud Welder

A new portable stud welder, consisting of a welding transformer and control mounted in a portable steel cabinet, primary and secondary cable, and a stud-welding gun, has been made available by the General Electric Company, Schenectady, N. Y. The stud welder is an equipment for fusing the end of a stud into a metal surface—applications include welding studs to steel surfaces for hanging piping, conduits, signs, instruments, hooks, and insulating materials.



A stud is placed in the welding gun, pressed against the surface to which it is to be welded, and one automatically timed impulse of power completes the weld.

One side of the portable steel cabinet is equipped with split steel doors which gives access to the control panel. Opening the upper door automatically removes power from the panel; adjustment of current and time for different sizes of studs are made with this upper door open. The lower door is used for servicing and normally can be kept locked.

The transformer is mounted in the cabinet behind the control panel and is connected to the power supply through a 20-foot double-conductor drag cable. The secondary of the transformer supplies heavy current at low voltage to the welding gun through hollow, forced-air-cooled flexible cables. The cooling air is admitted at both ends of each cable and is allowed to bleed out over its entire length. The secondary windings of the transformer are also forced-air-cooled, permitting the use of the minimum of material for a given capacity; in this manner obtaining as high a degree of portability as possible. The weight of the complete unit, less the cables, is approximately 500 lbs.

The welding gun is a tool for holding the stud against the work under spring pressure, and for properly directing the welding current. The gun is light in weight—most parts being of aluminum—and will accommodate studs of from ⅛" to 5/16" in diameter and from ½" to 2½" long. A control switch in the spade-type handle of the gun controls the operation of an automatic timer located on the control panel. When the gun switch is closed, current flows for a definite period of time only, regardless of how long the switch is held closed. The timer is adjustable for periods of from 1/12 to 5/6 of a second, the exact time used depending on the size of stud being applied. Once adjusted, the timer repeats the desired duration of current flow for each weld.

The new G-E stud welder is obtainable for single-phase power supplies of from 25 to 60 cycles—110 to 550 volts.

G-25 Insulating Fire Brick

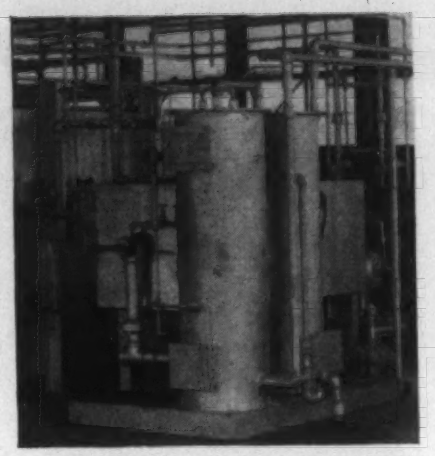
The A. P. Green Fire Brick Co., Mexico, Mo., announces their new G-25 insulating fire brick, which is recommended for use in oil, gas and electric furnaces for temperatures up to 2500°F., where slagging or severe abrasion is not encountered. The physical characteristics of G-25 are as follows: Weight—42 lbs./ft.³; Cold crushing strength—220 lbs./in.²; Transverse crushing strength—170 lbs./in.²; Refractoriness— P C E 32-33; Spalling, new A.S.T.M. panel spalling test consists of 12 cycles of 10 mins. in fire at 2500°F. and 10 mins. before air and water spray—no spalling apparent; Hot load panel test, 8 lbs./in.² at 2500°F.—no deformation.

Improved Bessemer Screw Stock

The Union Drawn Steel Co., Massillon, Ohio, has succeeded in developing a process for the manufacture of Bessemer screw steels said to largely eliminate the abrasive elements which tend to wear away the cutting edges of tools. This advancement has been accomplished, according to statements of the company, without change in analysis and without in any way affecting the physical properties of the material. While no higher feeds and speeds are claimed beyond those already obtainable with steels of these analyses, this development is said to have effected important production economies through extension of tool life and elimination of frequent machine shutdowns for regrinding with their accompanying loss of production. Steel so processed was first carefully tested by the company's own engineers, showing an increase of from 100 to 400% in tool life. It has since been tried in a number of large screw machine plants where similar favorable results have been obtained on long runs where tool wear was formerly excessive. The new development is now being employed in the production of both Union Free Cut (S.A.E. 1112 type) and Union Supercut (high sulphur) Bessemer screw steels and all steels of these grades.

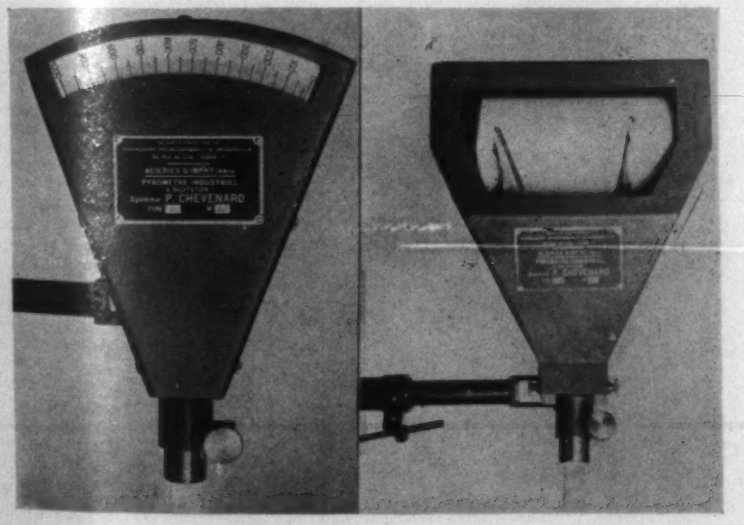
DX Gas Unit

The Surface Combustion Corporation, Toledo, Ohio, announce the development of the DX gas unit for controlled atmosphere furnaces. It is claimed that this unit will replace straight natural gas where used as an atmosphere at a saving of more than 75%. Standard size units, for preparing gas used for bright annealing, are available in capacities from 500 to 15,000 cubic feet per hour.



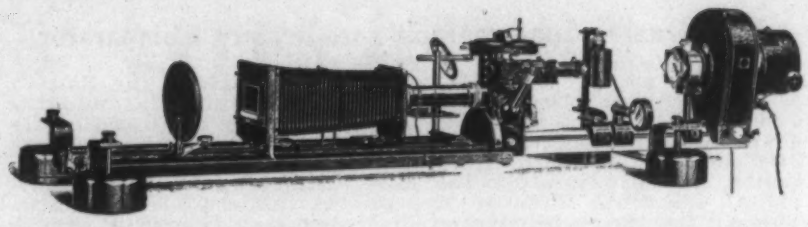
Expansion Type Industrial Pyrometers

Through their American agents, The R. Y. Ferner Co., Washington, D. C., the Acieries d'Imphy, are placing on the market a line of industrial pyrometers designed by Dr. Chevenard. These make use of the difference of expansion of a rod of Pyros and the fused silica tube in which the Pyros rod is contained. Pyros is an alloy developed to withstand repeated cycles of heating to 1100° C. (2000° F.) and cooling without changing its characteristics or showing appreciable oxidation. The differential expansion of the pyros and the silica is communicated through a silica push rod to a lever of Invar which carries a pointer moving over a scale graduated to 5° or 10° intervals, according to the range of the instrument. The instruments are supplied in 3 ranges—up to 300°, 600° and 1000° C.—and with 4 lengths of the silica tube, 0.450, 0.600, 1.0 and 1.4 meters. The exterior diameter of the longer tubes is 16 mm., or of the shorter ones 8 mm. The lengths of the Pyros standards vary from 100 to 225 mm. The instruments are supplied in five types. Types A and B are dial instruments, Type A being merely an indicating instrument while Type B can be used as a controller. The other 3 types are fitted with a revolving drum driven by clock-work, on which in Type C the temperature is merely recorded. In Type E the temperature is similarly recorded but the instrument can be used as a controller. With the third one, Type F, a desired cycle of temperature can be imposed on the furnace or bath which is being controlled. This is accomplished by securing on the drum a thin strip of silver cut to the curve of temperature desired. The contact point on the needle makes contact with this to open and close the heating circuit in a manner similar to the controlling instrument. When the pointer makes contact with the silver strip the relay breaks the circuit to the furnace but when, by revolving of the drum or the cooling of the furnace, the pointer leaves the silver strip, the circuit to the relay is broken and the mercury switch is closed to increase the heat until the pointer again comes in contact with the strip. A rheostat can be used in the heating circuit to adjust the current to give just enough current to maintain the highest temperature desired. The use of a fused silica tube in these pyrometers has the advantage of very small expansion, very small thermal conductivity, rigidity at high temperatures, and translucidity permitting rapid heating of the pyros standard by radiation. Though fragile in appearance the tubes are sufficiently strong for their manipulation without difficulty. They can be heated very rapidly without harm.



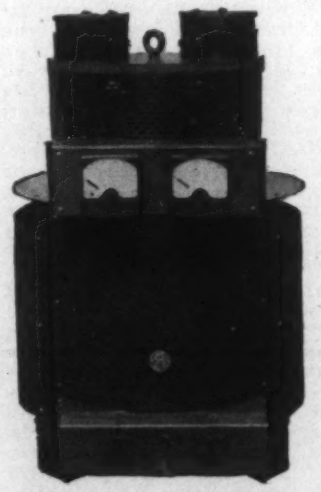
New Optical Bench

Carl Zeiss, Inc., New York, announce the new Zeiss-Neophot for microscopic observation and photography at magnifications of 4 to 2000X and for macro-photography with a photographic objective at full size at slight magnification or reduction. The illuminator combines in itself the various possibilities of bright field work with prism or plane-glass illuminator, dark-field work and polarized light illumination in such a way that the change from any one type of illumination to any other can be effected quickly and easily, without having to disturb the adjustment of the object or the focus. The prism illuminator is brought into use by simply pushing in a pin on the illuminator housing and interposing an auxiliary lens between the filter holder and the radient-field stop.



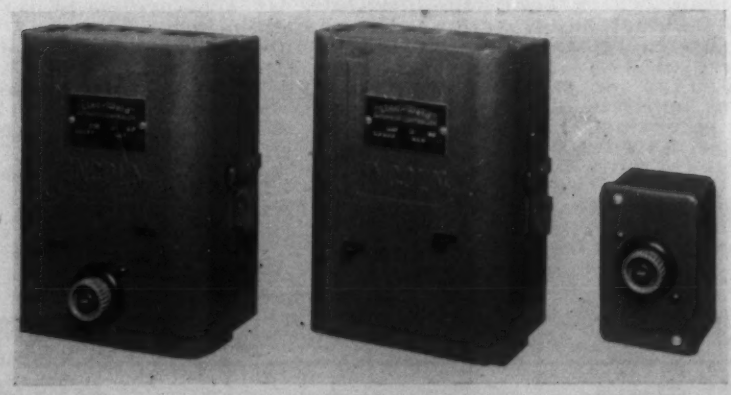
New A.C. Arc Welding Equipment

The General Electric Co., Schenectady, N. Y., now has available a complete line of a.c. arc-welding equipment including transformer units, electrodes, and automatic welding heads and control. The new a.c. equipment is intended for heavy-current welding—primarily automatic welding because of the heavy currents involved, but otherwise equally well suited to hand applications. A-C arc welding is not new, but the remarkable development of arc-welding electrodes during the last few years has only recently made it possible to benefit from the major advantage of the a.c. process—that advantage being the absence of magnetic blow in the arc, and therefore superior quality in the resulting weld. Slightly greater welding speeds are possible when using a.c., and in making fillet welds and in working into corners and other parts of intricate structures, the a.c. arc permits full penetration to be obtained. The new transformer units are available in 3 sizes having one-hour ratings of 500, 750, and 1000 amps. Primaries are wound for 220, 440, or 550 volts; 60, 50, or 25 cycles; single phase. Extra attachments are available for reducing the secondary open-circuit voltage to approximately 50% of its normal value (normal being 80, 90, or 100 volts), and for obtaining currents down to 10% of the one-hour rating. The transformers themselves are of the high-reactance type, air-cooled and enclosed in a sturdy cylindrical shell. A suitable arrangement is provided to vary reactance so that the full welding range of the equipment can be obtained on any one of three secondary open-circuit voltage settings—the latter being selected by means of taps on the primary winding. The new a.c. equipments are intended primarily for shop use in semi-permanent locations, a lifting eye being provided on top of the transformer unit by means of which the set can be readily moved by a crane.



New Motor Starter

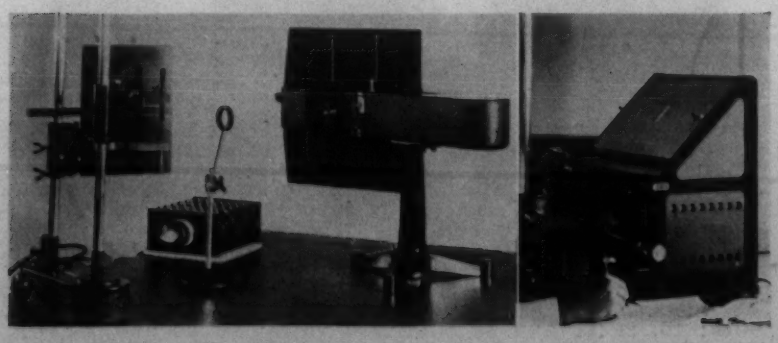
A new line of automatic motor starters, which, it is stated, prevents accidental starting and which permits taking full advantage of the motor's capacity without danger of burning it out, is announced by The Lincoln Electric Company, Cleveland, Ohio. This starter is of the across-the-line type and fully meets underwriter's requirements. It is impossible to close the starting current unintentionally due to the design of the control. The red stop button extends around and beyond the green start button. Consequently, a bump or a fall against the control would move only the stop button. Once the motor is stopped, the only way it can be restarted is by pressing the recessed start button with the fingertip. Full advantage of the motor's capacity is permitted by an inverse time limit protection which allows carrying a small overload a long time or very heavy load a short time. Immediate motor starting upon resumption of current is insured by low voltage release with two wire control. The new starters are furnished in 3 types for different horsepowers and 110, 220, 440 and 550 volts. The XLA starter is for 3 and 5 H.P. motors, 110 volts; also 3, 5, 7½ and 10 H.P., 220, 440 and 550 volts. The XLB starter is for 7½ and 10 H.P., 110 volts; 15, 20 25 and 30 H.P., 220 volts; 15, 20 and 25 H.P., 440 volts; and 15 and 20 H.P., 550 volts. The XLBB is for 30 H.P., 440 volts; and 25 and 30 H.P., 550 volts.



New Quartz Spectrograph and Density Comparator

The new small Littrow Quartz Spectrograph of the Bausch & Lomb Optical Co., Rochester, N. Y., is designed for industry and education. It is simple in design, sturdily built and easily portable. The range covered by this spectrograph is from 2100 to 7000 A.U. and the linear dispersion between these limits is approximately 150 mm. The length of the individual spectrum lines on the photographic plate is 3 mm. This entire range is covered in a single spectrogram, hence no adjustments of lens or prism are required as in larger instruments of the Littrow type. This permits rigidity and permanence of adjustments, since the optical system has no movable parts. The instrument is not intended to replace the medium or large spectographs for work on complex spectra, where the lines are very close together and require high resolving power and dispersion for satisfactory separation of the lines. It does afford a longer and more easily read spectrum and a greater precision of measurement than any other small spectrograph. In the case of simple spectra, especially the non-ferrous metals, this instrument provides a very rapid tool for analysis. This is particularly true if the desired information can be obtained in the short wave-length portion of the ultra violet, where the linear dispersion and resolving power of a quartz spectrograph are much greater than at long wave-lengths. The detection of silver, copper, bismuth, tin, and antimony in pig lead; and of silver, lead and iron, in copper; also of tin, lead, cadmium, and magnesium, in zinc-base die casting alloys, are typical examples. Under favorable conditions this instrument can also be used for quantitative work. The requirement is that the spectrum lines of the element to be determined must be clearly separated from neighboring lines of other constituents. On materials giving relatively simple spectra the same precision can be obtained with this small spectrograph that is obtainable with a larger instrument. The small Littrow is ideally suited to absorption analysis. Absorption spectra are usually made up of rather broad and not very sharply defined bands, so that too high dispersion is often a hindrance rather than a help. For work of this character it is highly desirable to use a spectrograph without too great a dispersion and one that will photograph the complete spectrum with a single exposure, so that all the required information is contained on a single plate. The optical system of the small Littrow is of crystal quartz of the "Auto Collimating" type, in which a prism with a metallic reflecting back is used and a single lens serves both as collimator and camera lens. The light entering the slit is rendered parallel by the lens and is refracted upon entering the prism. Upon striking the metallic coating it is reflected back along a path nearly parallel to the entering beam. It is again refracted upon leaving the prism and is focused as a dispersed spectrum upon the photographic plate by the same lens that collimates the entering light. This design permits, for a given overall length, much greater focal length and linear dispersion than is found in quartz spectrographs of the ordinary type. Four standard slits are provided, of two, five, ten and twenty microns cut in a properly protected silver coating deposited on a single quartz slide. The slit widths are indicated in microns on the face of the slide. The particular advantages of this type are: stability, parallelism of edges and ease of cleaning. The plate holder is a standard Graflex type, 5 x 7″ size, especially adapted for use on this spectrograph. The septum between the two slides has been removed to permit one slide to be used for loading and the other for exposure after the holder has been placed in the spectrograph. The plate is bent over curved guides to meet the focal curve of the lens and a scale indicates the location in the vertical direction and provides for the proper spacing of exposures.

The new Density Comparator is an instrument designed for accurate and rapid quantitative spectrographic analysis. It is built as an accessory instrument to any spectrograph. The intensities of spectrum lines are measured by photoelectric means and the results read directly from a scale. For work involving the measurement of but a few selected lines, which is the usual case in quantitative spectrography, it surpasses the recording types of micro-photometers in rapidity and in providing, at unusually low cost, an instrument which accurately measures intensities. It is free from the personal equation of the operator and the effects of fatigue, which limit the accuracy of measurements made with visual photometers. Computations can be made at once without waiting for the development of a photographic paper of film. It may be used for plates taken with any size, type, or make of spectrograph. The complete equipment consists of a projection system, a photo-electric cell for reception, a voltage regulator, and a sensitive galvanometer mounted on a Julius Suspension. The current for the standard unit is 110 volt, 60 cycle a.c. Provision is made for other voltages and frequencies. The illuminator is located inside the housing of the instrument and consists of a 200 watt monoplane filament lamp equipped with a reflector, and is focusable.

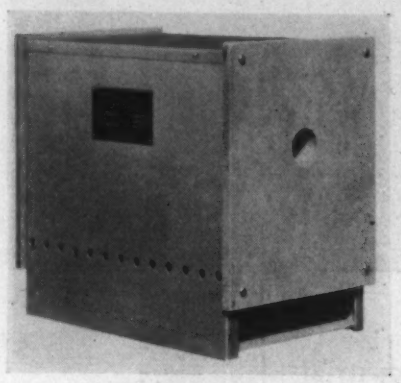


Spectrograph

Comparator

High Temperature Combustion Tube Furnace

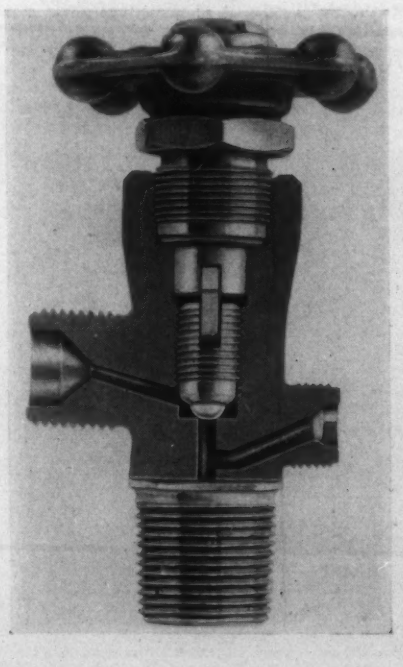
A new tube furnace is announced by Hevi Duty Electric Company, Milwaukee, Wis. The furnace shell is of sheet steel fitted with asbestos heads at each end, and is lined with a high grade insulating brick having low heat conductivity. The chamber of the furnace, insulated from the asbestos heads, is 12″ long and of sufficient diameter to accommodate combustion tubes up to 1¾″ outside diameter. The heating element, in the form of a helical coil, is designed particularly for operating temperatures beyond the usual nickel-chromium element range. It is mounted on a ceramic refractory tube, and may be readily inserted through the top. The top portion of the furnace is removable. The long life of the coil reduces the maintenance cost, and greatly increases the utility of this type of furnace. The ability to withstand rapid heating is characteristic of this new metallic element. The furnace structure gives greater speed and accuracy in the laboratory.



The terminals extend through the bottom of the furnace where a free circulation of air keeps them relatively cool. Connections are thus readily accessible.

Temperature regulation is obtained by means of a rheostat which regulates the furnace between 1100° and 2300° F. The temperature may be varied with little loss of time when necessary for different samples. The furnace requires a transformer which may be connected to either a 110 or 220 volt power line.

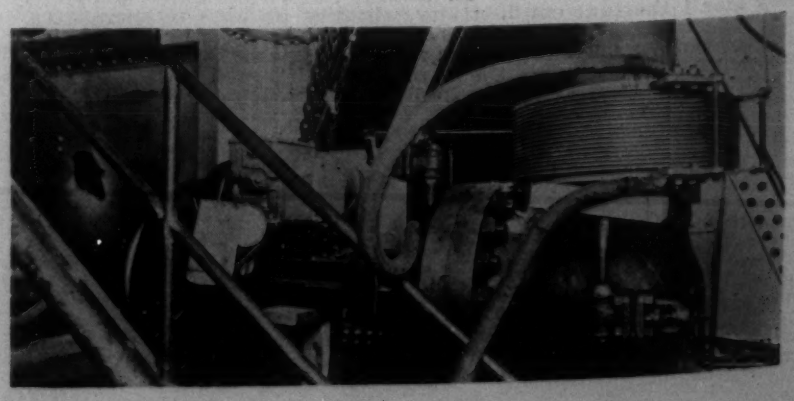
Ball-Seat Valves



Air Reduction Sales Co., New York, N. Y., announce that more than 96% of all of "Airco" oxygen cylinders have recently been equipped with a new type of valve which, while it closely resembles the older type valve in appearance, differs in construction in that a hardened stainless steel ball forms the seat. The valves not only open and close easily but they are said also to possess superior sealing qualities and they do not corrode or score and cause leaks. For more than three years similar types of hardened stainless steel ball valves have been used on all Airco-DB torches, and it is said as a result of this experience that such torches rarely require valve repairs other than the occasional renewal of valve stem packing.

New Weld Stress Reliever

An electric weld stress reliever for pipes ranging from 6″ to 24″ is being offered by Detroit Electric Furnace Company, Detroit, Mich. The equipment has been designed for normalizing welded joints in pressure piping systems and is especially useful for field operation, in the opinion of the manufacturers. Jointed rings of various sizes are provided to fit pipes of diameters described. Power is supplied for a special transformer which, with necessary control equipment, is mounted on a hand-truck for ease of field operation. Induction heat is applied to the areas to be relieved in accordance with predetermined values. Speed, cleanliness and precise control are claimed as outstanding advantages for the equipment.



MANUFACTURERS' LITERATURE

Note: (This department is conducted for the convenience of the readers of METALS & ALLOYS *desiring to add to their files copies of current literature issued by manufacturers. Any items desired can be secured free by applying direct to the issuing firms or in those cases where a number of items are wanted applications may be sent direct to this office. A coupon is provided on which the numbers of the items required can be listed.)*

G-25 Insulating Fire Brick

Bulletin, just off the press, containing a full and complete story of this new product. A. P. Green Fire Brick Company, Mexico, Mo. (399)

Automatic Pump Controller for Elevated Tank Systems

Leaflet illustrating and describing this automatic pump controller. Hookup diagrams, standard specifications, data on special applications, etc. Minneapolis Honeywell Regulator Co., Minneapolis, Minn. (400)

Ampco Metal

Data sheet No. 7 is the seventh of a series of data sheets published monthly. This sheet deals with the handling of Ampco Metal. Recommendations given are derived from the manufacturer's experience over a number of years. Ampco Metal, Inc., Milwaukee, Wis. (401)

Bluehead Electric Furnaces

Catalog No. 34 sets forth data on these furnaces for use in the laboratory. Illustrations, specifications, etc. are included. Cooley Electric Furnace Co., Indianapolis, Ind. (402)

Torsion Impact Testing Machine

Bulletin No. 78 is a six-plate booklet describing this machine. Tells how it functions and reveals by means of graphs, etc. some of the results found in tests of hardened steels. A Bibliography on impact testing is appended. Baldwin-Southwark Corporation, Philadelphia, Pa. (403)

Struthers-Weld Certified Machine Parts

Illustrated booklet, 10 pages, containing data on these machine parts. Radiographs, photographs, etc. Struthers-Wells Company, Warren, Pa. (404)

Houghto-Clean

Interesting booklet containing a brief outline describing the use of the Houghto-Clean series of cleaning materials for metal working plants. E. F. Houghton & Co., Philadelphia, Pa. (405)

Gas Carburizing

Leaflet containing reprint of Mr. H. W. McQuaid's paper on Gas Carburizing (a discussion of shop practices) as printed in the July issue of *Metal Progress*. Everyone interested in this subject should have this leaflet in his file. Surface Combustion Corporation, Toledo, Ohio. (406)

Ampco Metal

Catalog No. 20 describes this metal and sets forth its uses in modern industry. Illustrations, tables, charts, etc. 32 pages. Ampco Metal, Inc., South 39th and West Burnham Streets, Milwaukee, Wis. (407)

Bakelite Bonded High Speed Abrasive Wheels

Booklet illustrating and describing these fast cutting, safe and economical abrasive wheels. 24 pages. Bakelite Corporation, River Road, Bound Brook, N. J. (408)

Aminco Laboratory Instruments

Catalog made up of bulletins arranged in sections according to the purpose for which the apparatus is intended. Completely indexed, and illustrated. American Instrument Co., Inc., Washington, D. C. (409)

Duriron Acid-Proof Equipment

Looseleaf binder containing bulletins on the subjects of pumps, valves, Pipe jets, kettles, coils, fans, laboratory equipment, ducts and price lists. Illustrations, charts, tables, etc. The Duriron Company, Inc., Dayton, Ohio. (410)

Masters of Metal

Brochure containing the story of Scovill in three parts beautifully illustrated with photographs by Russell Aikins. 20 pages. Scovill Mfg. Co., Waterbury, Conn. (411)

Aerocase

Booklet on this subject. Illustrations, curve charts, tables. American Cyanamid and Chemical Corp., 30 Rockefeller Plaza, New York, N. Y. (412)

Rockwell Hardness Tester

Catalog R-8 illustrates and describes this tester for use on all metals, hard or soft, polished or unpolished, flat, round, tubular or odd in shape. For research or precision work in the laboratory or quantity inspection testing in the shop. Wilson Mechanical Instrument Co., Inc., 383 Concord Avenue, New York, N. Y. (413)

Grinding Wheels

A treatise on the dressing and truing of grinding wheels, by H. J. Wills, Sales Research Department. Profusely illustrated and containing tables, diagrams, etc. The Carborundum Company, Niagara Falls, N. Y. (414)

Dow Chemicals

New catalog in which is presented pertinent information on the properties, specifications and uses of Dow products, including shipping classification and packages. It is intended tha this data will serve a useful purpose for buyers, plant superintendents and research men. Over 250 products are listed comprising heavy, industrial, pharmaceutical, and aromatic chemicals; solvents, insecticides, dyes, magnesium and Dowmetal. 101 pages. The Dow Chemical Co., Midland, Michigan. (415)

Die Casting Machine

Leaflet announcing Kippcaster 15GF and the new automatic No. 5. Illustrated and described. Madison-Kipp Corp., 20 Waubesa St., Madison, Wis. (416)

Vanadium in Steel Castings

Treatise by Jerome Straus, reprinted from Transactions of the American Foundrymen's Association. Illustrations, tables, etc. Vanadium Corp. of America, 120 Broadway, New York, N. Y. (417)

Power Plant Instruments

The purpose of this book is to provide data from which a suitable plan of instrument equipment covering most operating needs may easily be worked out for any steam plant. Contains 105 applications of instruments to the steam power plant for measuring temperatures, pressures, flows, liquid levels %CO, and speeds. Also contains diagram of instrument applications in the steam power plant. 47 pages. The Brown Instrument Co., Wayne and Roberts Aves., Philadelphia, Pa. (418)

Zeiss Micromanipulator

Booklet illustrating and describing this apparatus which serves for the manipulation of microscopic objects under any required magnification with the aid of very fine so-called micro-instruments. Carl Zeiss Inc., 485 Fifth Avenue, New York, N. Y. (419)

Riverside Nickel Silver

Booklet, the preparation of which was prompted by the requests for specific data about Nickel Silver which are frequently received from fabricators' engineering staffs, research laboratories and purchasing departments. Riverside Metal Company, Riverside, N. J. (420)

Crawford Ovens

Binder containing bulletins illustrating and describing these industrial ovens for japanning, low temperature enameling, lacquering, baking armatures and insulating varnishes, low temperature heat treating, drying processes. Photographs, charts, diagrams, tables, etc. are included. The Crawford Oven Co., New Haven, Conn. (421)

Ideal Industrial Machinery

Looseleaf catalogue containing full information on this machinery for tumbling, separating, cleaning, washing, burnishing, plating and pickling metal parts. Profusely illustrated. N. Ransohoff, Inc., Cincinnati, Ohio. (422)

Mallory Elkon

Looseleaf catalogue containing engineering data with descriptions, illustrations and recommendations for the selection of electrical contacts for all types of service. P. R. Mallory & Co., Inc., Indianapolis, Indiana. (423)

High Temperature Insulation

Valuable data is contained in pamphlet on this subject. Curve charts, photographs, diagrams, etc are included. Johns-Manville Corp., 22 East 40th St., New York, N. Y. (424)

Ludlum Steel Blue Sheets

Issued by the Research Department for engineers and executives interested in data and reference material regarding its steels and their properties as disclosed by actual tests. Ludlum Steel Company, Watervliet, N. Y. (425)

When All Else Fails—They Hold

Booklet illustrating and describing the Baldt "Di-Lok" Drop forged, alloy steel chain and Baldt (patented) Detachable Links. Table of chain dimensions. Baldt Anchor & Forge Corp., Chester, Pa. (426)

Homo Method for Production Tempering

Catalog No. 93 explains the Home Method—what it is and what it does. Photographs, curve charts, diagrams, structural features, temperature record charts are included. Leeds & Northrup Co., Philadelphia, Pa. (427)

Sand Testing Equipment

Reference book on sand testing and foundry control equipment and contains also valuable sand data. Additional sheets to be included in looseleaf binder sent on request. Illustrations, specifications, are included. Harry W. Dietert Co., 676 W. Grand Blvd., Detroit, Mich. (428)

Kramer Alloy News

Interesting little paper of interest to all users of non-ferrous ingot metals and published at intervals by H. Kramer & Co., Chicago, Ill. (429)

M-C-M Industrial Chemicals

Leather bound booklet (4th edition) containing valuable data on this subject, their properties, uses, shipment, etc. Charts, tables, illustrations are included. Merrimac Chemical Company, Inc. (Division of Monsanto Chemical Works), Everett Station, Boston, Mass. (430)

Camograph, Omnigraph and Tramograph

Booklet illustrating and describing the Airco-D-B group of machines for quantity production to cam or templet. Air Reduction Sales Co., 60 East 42nd Street, New York, N. Y. (431)

Your Questions Answered

Booklet containing brief answers to question about Norton pulpstones relating to quality, flexibility, durability and dependability. Norton Company, Worcester, Mass. (432)

Midvale High Speed Tool Steels

Booklet setting forth data on high speed tool steels. Illustrations, tables, diagrams, are included. The Midvale Co., Nicetown, Philadelphia, Pa. (433)

Bethlehem Tool Steels

Handsome Catalog L-I, leather bound, contains a wealth of information on tool steels. Illustrations, tables, detail drawings, are included. Bethlehem Steel Co., Bethlehem, Pa. (434)

Nichrome

Booklet profusely illustrated sets forth the uses of this heat-resisting alloy under widely varying conditions. Driver-Harris Co., Harrison, N. J. (435)

Vanadium Additions Improve Steel

Article prepared from a paper read before the Sixth International Congress of Mining, Metallurgy and Applied Geology in Liege, Belgium. The author being N. Petinot, Assistant to President of Vanadium Corporation of America. Reprinted from *Steel* it presents to its readers an authentic and comprehensive article on the development of Vanadium-containing steels, the properties and present application of these steels in major industries. Vanadium Corporation of America, 120 Broadway, New York, N. Y. (436)

Oil Burning System

Bulletin A sets forth data on this system for boilers. Illustrated. The Anthony Company, Long Island City, N. Y. (437)

Rubber Products for the Oil Industry

An oil man's booklet, compiled especially for his convenience and interest. The products it describes are made to fit conditions under which he works. Illustrated. The Manhattan Rubber Mfg. Co., Passaic, N. J. (438)

Engineering Data Book of Condor V-Belt

This data book has been prepared to provide in handy, concise form a compendium of information for those interested in quality belts for industrial V-Belt drives. Illustrations, tables, charts, etc. are included. The Manhattan Rubber Mfg. Division of Raybestor-Manhattan, Inc., Passaic, N. J. (439)

UNA

Booklet containing data on this modern arc welder dynamotor type of construction. Illustrations, curves, are included. Una Welding & Bonding Co., Cleveland, Ohio. (440)

Conquering Rust

Interesting 23-page booklet on the subject indicated as applied to the corrosive environments that iron and steel products encounter in service. National Tube Company, Pittsburgh, Pa. (441)

Matched Thread Perfection

Booklet No. 18 recently published in the pages of which is described and illustrated the development of threading tools, for threading both couplings and pipe. The Youngstown Sheet and Tube Company, Youngstown, Ohio. (442)

Degreasing Machines

Booklet containing descriptions and illustrations covering a new thorough, rapid, economic and essential method for removing oil, grease and dirt from metal and other miscellaneous parts. G. S. Blakeslee & Co., Cicero Station, Chicago, Ill. (443)

Electric Arc Saw

Leaflet describing and illustrating this saw which it is claimed cuts iron, steel and alloy metals in an easy, rapid and economical way. Rich Mfg. Co., Ltd., 3851 Santa Fe Ave., Los Angeles, Calif. (444)

Thwing Instruments

Bulletins in looseleaf binder containing data on thermocouples and protecting tubes, radiation pyrometers and daily chart recorder. Profusely illustrated. Thwing Instrument Company, 3339 Lancaster Ave., Philadelphia, Pa. (445)

Immersion Units

Leaflet containing data on these units for heating oils, salts, waxes, compounds, etc. Illustrated. Harold E. Trent Company, 618 N. 54th St., Philadelphia, Pa. (446)

Morgan Producer Gas Machine

Attractive booklet in the pages of which is set forth complete data on this machine. Illustrations, detail drawings, cross sections, typical installation, summary of operating tests, coal analysis, etc. Morgan Construction Co., Worcester, Mass. (447)

Automatic Furnace

Catalogue illustrating and describing this furnace for cyanide hardening and heat treating by other liquid bath processes. Specifications, detail drawings, etc. Parker-Kalon Corp., 200 Varick Street, New York, N. Y. (448)

Coloring Copper, Brass and Bronze

Special attention is called to the presentation in this revised pamphlet (No. 15B) of a newly developed process for obtaining artificially the greatly admired natural patina on copper. The data and information given are the results of thorough study by The Copper & Brass Research Association, 25 Broadway, New York, N. Y. (449)

Hot and Cold Rolled Strip Steel

Booklet descriptive of Acme hot and cold rolled strip steel for stamping, forming and deep drawing. Acme Steel Company, 2840 Archer Avenue, Chicago, Ill. (450)

Ajax Bulletin

Illustrated bulletin showing various continuous and batch type electric furnaces for bright annealing, copper brazing, strip annealing, wire annealing, etc. Also the Ajax Electric Ammonia Dissociator for producing hydrogen for furnaces using a reducing atmosphere. Ajax Electric Co., Frankford Ave. and Allen St., Philadelphia, Pa. (451)

Zinc Die Casting Alloy Aging Data

Reprinted from the May, 1934, issue of METALS & ALLOYS, this article by E. A. Anderson, Chief, Metal Section, Research Division, The New Jersey Zinc Company, and G. L. Werley Investigator, Metal Section, Research Division, of the same firm, contains a wealth of valuable material. The article is a complete report on these aging tests brought up-to-date. The New Jersey Zinc Company, 160 Front Street, New York, N. Y. (452)

Mill Products

Comprehensive booklet, published August, 1934, in which is contained general information on this subject, including cutting tables, data tables, millimeter and inch tables, temperature conversion table, etc. Scovill Mfg. Co., Waterbury, Conn. (453)

Carbon Tool Steel

Booklet on this subject containing much useful information. Tempering tables, curves, etc., are included. Midvale Co., Nicetown, Philadelphia, Pa. (454)

Refractories for Steel Pouring Equipment

Paper by R. H. Stone, chemical engineer, Vesuvius Crucible Co., and reprinted from *Blast Furnace and Steel Plant*, issue of June, 1931. Vesuvius Crucible Co., Swissvale, Pa. (455)

Cast Nichrome Carburizing Containers

Bulletin containing information on this subject. Illustrated. Driver-Harris Co., Harrison, N. J. (456)

Gas Fired Pot Furnaces

Leaflet illustrating and describing this type of furnace for heavy duty. Bellevue Industrial Furnace Co., 2971 Bellevue Ave., Detroit, Mich. (457)

Hyb-Lum

An outline guide for the proper working in the foundry and machine shop of this light, high strength aluminum alloy. Sheet Aluminum Corp., 701 Liberty St., Jackson, Mich. (458)

"Iron Peerless" Brick

Leaflet containing data on Kentucky quality refractories. The Ironton Fire Brick Co., Ironton, Ohio. (459)

Isley Furnace System

Bulletin No. CC-1001 gives complete data on this system, what it is and how it does its work. Morgan Construction Co., Worcester, Mass. (460)

Bellis Furnaces

Leaflet announcing new models for annealing and stamping stainless brass, silver, gold, nickel and steel. Illustrated. The Bellis Heat Treating Co., Branford, Conn. (461)

Tophett for Top Heat

Revised list prices and supplementing 1931 Gilby Resistance Hand Book, this pamphlet gives full data about Tophet "A", a nickel chromium alloy for extreme temperatures. Gilby Wire Co., Newark, N. J. (462)

Moore Rapid Lectromelt Furnaces

Leaflet describing and illustrating these furnaces. Schematic cross sections, photographs, diagrams. Bulletin CA. Pittsburgh Lectromelt Furnace Corp., Pittsburgh, Pa. (463)

Duplexing with Cupola

Interesting paper by H. E. Bromer, Metallurgist, Standard Foundry Co., reprinted from May, 1930, issue of *The Iron Age*. Pittsburgh Lectromelt Furnace Corp., Pittsburgh, Pa. (464)

New Carburizing Process

A booklet of 24 pages, illustrated with charts and graphs gives full details on the Perliton process and materials for carburization. It is claimed Perliton is especially adapted for carburizing work requiring a depth of case from skin hardness to .04 inch. E. F. Houghton & Company, 240 W. Somerset St., Philadelphia, Pa. (465)

Copper, Brass, Bronze and Zinc Plating with Copper Cyanide and Zinc Cyanide

Operating manual for copper, brass, bronze and zinc plating with du Pont copper and zinc cyanides. Presents information on the specifications and methods of using copper and zinc cyanides produced by du Pont. Sections are devoted to instructions on making the plating solutions, operating, analyzing the solution and cleaning the metal prior to plating. Under the twenty-two divisions of the general subject there are such discussions as the advantages of using metal solutions, copper plating preparatory to localized hardening of steel, preparation of plating baths, formulas for solutions, methods of analysis and various others. Just off the press and prepared by the technical staff of the R & H Chemicals Department. E. I. du Pont de Nemours & Company, Wilmington, Del. (466)

Electric Furnaces

Leaflet TD-20 illustrating and describing pot and trough types. Cross section, photographs, tables. Harold E. Trent Co., 618 No. 54th St., Philadelphia, Pa. (467)

Oxwelding Aluminum and Its Alloys

A discussion of current practices in oxwelding the commercial grades of aluminum. Illustrated. The Linde Air Products Co., 30 East 42nd St., New York, N. Y. (468)

Make This Free Test

Leaflet containing information about Harwaco Bond and telling how you may obtain a free 5 pound sample for a test of its strength. Harbison-Walker Refractories Co., Pittsburgh, Pa. (469)

P-G-M Metal

Leaflet announcing this metal for casting, forging, rods and shapes. Illustrated. Cramp Brass and Iron Foundries Co., Paschall Station, Philadelphia, Pa. (470)

Cold Finished Shafting

Booklet containing valuable information on the functions of steel in industry concerning its use as shafting. Union Drawn Steel Co., Massillon, Ohio. (471)

Acid Resisting Castings

Leaflet setting forth data on acid-resisting valves, cocks, pump parts and casting for the chemical, petroleum and allied industries, also wherever corrosive liquids are used. Pioneer Alloy Products Co., Inc., 1660 Euclid Ave., Cleveland, Ohio. (472)

Wire Mill Equipment

Bulletin No. 7536 contains data on Morgan-Connor wire machines. Illustrated. Morgan Construction Co., Worcester, Mass. (473)

Horizontal Bull Block

Bulletin No. 757 sets forth information on this wire mill equipment. Illustrated. Morgan Construction Co., Worcester, Mass. (474)

Friction Driven Rod Blocks

Bulletin No. 753 illustrates and describes these blocks for use in wire mill equipment. Morgan Construction Co., Worcester, Mass. (475)

High Tensile Steels

Booklet announcing a new group of USS High Tensile Steels for light weight construction, which are being manufactured in three grades by seven of the subsidiary companies of the United States Steel Company. United States Steel Corporation Subsidiaries, Frick Building, Pittsburgh, Pa. (476)

Sterling Stainless Steels

Three bulletins, just issued, on this product. Bulletin No. 1 contains data on Type "A" and "B" developed for purposes where high degree of hardness, resiliency and resistance to abrasion are required in highly corrosion-resistant steel. Bulletin No. 2 tells the story of Blue Chip High Speed Steel for general use on machining operations. Bulletin No. 3 tells the story of Circle C Super High Speed Steel particularly adapted for "high production." All bulletins contain drawing data tables, analysis, physical properties and working data. Firth-Sterling Steel Company, McKeesport, Pa. (477)

Stiffness Tester

Bulletin E-10133 is a technical description of Smith-Taber Model "A" Precision Stiffness Tester, for the scientific measurement of stiffness and resiliency. Wilson Mechanical Instrument Co., Inc., 383 Concord Ave., New York, N. Y. (478)

Welding Wire and Equipment

A comprehensive treatise on the science of welding, together with facts and figures of inestimable value to all workers in metal never before published, and a complete line of electrodes, welding wire and welding equipment of proven worth. Hollup Corporation, 3357 West 47th Place, Chicago, Ill. (479)

High Temperature Electric Furnace

Booklet illustrating and describing this tube type electric furnace used chiefly for carbon determinations. Hevi-Duty Electric Co., Milwaukee, Wis. (480)

Speed Ultra Cut

Booklet setting forth information on this fast-cutting screw stock. Actual photographs of typical machine parts fabricated from Ultra-Cut Steel are shown. Bliss & Laughlin, Inc., Harvey, Ill. (480)

Bearing Bronze in Bar Form

Booklet illustrating and describing leaded bronze bearing stock for lathe or screw machine production. Aluminum Industries, Inc., Cincinnati, Ohio. (481)

Controlled Atmosphere Electric Furnaces

Booklet indicating briefly the many uses to which G-E controlled-atmosphere furnaces may be applied, with resultant improvements in quality of product as well as substantial reductions in costs. Typical installations of G-E furnaces and furnace-atmosphere controllers for annealing or normalizing without oxidation, for hardening without scale, and for electric-furnace brazing are included. General Electric Company, Dept. 6-201, Schenectady, N. Y. (482)

METALS & ALLOYS, 330 West 42nd St., New York, N. Y.

I should like a copy of each piece of Manufacturers' Literature listed below.

.....

Name .....

Position .....Firm .....

Street and Number .....

City .....State .....

ADVERTISERS' INDEX

OCTOBER ISSUE

Air Reduction Sales Company ..... A 56, A 57
Ajax Electric Company, Inc. ..... Outside Back Cover
Ajax Electric Furnace Corporation .... Outside Back Cover
Ajax Electrothermic Corporation ..... Outside Back Cover
Ajax Metal Company ..... Outside Back Cover
American Brass Company ..... A 12, A 13
American Chemical Paint Company ..... A 31, A 50
American Electric Furnace Company ..... A 48
American Rolling Mill Company ..... MA 497
American Sheet and Tin Plate Company ..... A 34, A 35
American Steel & Wire Company ..... A 34, A 35
Andrews Steel Company ..... A 82
Armstrong Cork & Insulation Co ..... A 69
Aurora Metal Company ..... A 78

Baldwin-Southwark Corporation ..... A 63
Basic Dolomite, Inc. ..... MA 481
Bausch & Lomb Optical Company ..... MA 491
Bethlehem Steel Company ..... A 75, A 76, MA 495
Bridgeport Brass Company ..... A 7
Bristol Company ..... A 49
Brown Instrument Company ..... A 72
Bull, R. A. ..... MA 501
Burgess-Parr Company ..... MA 496

Carborundum Company ..... A 44, A 45
Carnegie Steel Company ..... A 33
Chase Brass & Copper Company, Inc. ..... MA 497
Climax Molybdenum Company ..... MA 470
Columbia Steel Company ..... A 34, A 35
Copper & Brass Research Association ..... A 22

Dow Chemical Company ..... A 11
du Pont de Nemours & Company, Inc., E. I.
Roessler & Hasslacher Chemicals Dept. ..... MA 485
Duriron Company, Inc. ..... A 15

Electric Furnace Company ..... Inside Back Cover
Electro Alloys Company ..... A 20
Electro Metallurgical Company ..... A 19

Firth-Sterling Steel Company ..... MA 475
Foxboro Company ..... A 53

General Electric Company ..... A 84
General Electric X-Ray Corporation ..... MA 487
Gogan Machine Corporation ..... A 31

Handy & Harman ..... A 59
Hayes, Inc., C. I. ..... A 52
Hevi Duty Electric Company ..... MA 477
Holz, Herman A. ..... MA 489
Hotel Adelphia ..... MA 477
Hotel Gibson ..... MA 501
Hotel Secor ..... MA 484
Hotel William Penn ..... MA 484
Houghton & Company, E. F. ..... A 70, A 71

Illinois Steel Company ..... A 36
International Nickel Company, Inc. ..... A 25, MA 483

Johns-Manville Corporation ..... MA 478, MA 480
Jones & Laughlin Steel Corporation ..... A 8, A 9

Krembs & Company ..... A 31

Leeds & Northrup Company ..... A 41
Leitz, Inc., E. ..... A 65
Lincoln Electric Company ..... A 3

Mahr Manufacturing Company ..... A 77
Massillon Refractories Company ..... A 40
Maurath, Inc. ..... A 58
Metal & Thermit Corporation ..... MA 473
Metallurgical Advisory Service ..... MA 501
Mullite Refractories Company ..... A 14

National Tube Company ..... A 34, A 35
New Jersey Zinc Company ..... A 80
Nitralloy Corporation ..... A 4
Nitricastiron Corporation ..... A 5
Norton Company ..... MA 479

Ohio Ferro-Alloys Corporation ..... A 23
Ohio Steel Foundry Company ..... A 18

Phosphor Bronze Smelting Company ..... A 29
Pitkin, Inc., Lucius ..... MA 501
Pittsburgh Lectromelt Furnace Corporation ..... A 52
Pittsburgh Metallurgical Company, Inc. ..... MA 473
Pyrometer Instrument Company ..... A 50

Republic Steel Corporation ..... Inside Front Cover
Revere Copper & Brass, Inc. ..... A 28
Ryerson & Sons, Inc., Joseph T. ..... MA 497

Spencer Turbine Company ..... MA 477
Surface Combustion Corporation ..... A 37

Taylor Sons Company, Charles ..... MA 480
Technical Translation Bureau ..... MA 501
Tennessee Coal, Iron & Railroad Company ... A 34, A 35
Thompson Grinder Company ..... MA 488
Timken Steel & Tube Company ..... A 73
Titanium Alloy Manufacturing Company ..... A 24

Union Carbide & Carbon Corporation ..... A 19
United States Steel Corporation Subsidiaries
A 33, A 34, A 35, A 36

Vanadium Corporation of America ..... A 21
Vapofier Corporation ..... A 51

Wilson Mechanical Instrument Company, Inc. ..... A 62

Zeiss, Inc., Carl ..... A 67